Engineering Library

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AUG 29 1929

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

New Gear-Cutting Works at Birmingham. (P. 165)
THE ENGINEER, 16 - 8 - 29.

The Reclamation of the Zuyder Zee No. II. (P. 162)
THE ENGINEER, 16 - 8 - 29.

Single Lines of Railway. (P. 173)
THE ENGINEER, 16 - 8 - 29.

Transformer Tap-Changing on Load No. VI. (P. 176)
THE ENGINEER, 16 - 8 - 29.

Surge Protection on Transmission Circuits. (P. 174)
THE ENGINEER, 16 - 8 - 29.

The Sea. (P. 167)
(G. P. BIDDER.) THE ENGINEER, 16 - 8 - 29.

The Mumbles Railway and its Signalling. (P. 178)
THE ENGINEER, 16 - 8 - 29.

Accelerator for Hot Water Heating Systems. (P. 180)
THE ENGINEER, 16 - 8 - 29.

Oil Engine Air-Injection Process. (P. 169)
(J. S. BROWN.) THE ENGINEER, 16 - 8 - 29.

Rand Water Board—Annual Report. (P. 174)
THE ENGINEER, 16 - 8 - 29.

INDEX TO ADVERTISEMENTS, PAGE 95.

PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—
SCHEDULE 1.—6083 cwt. SPRING STEEL.
SCHEDULE 2.—60 BRAKEVANS, complete, for 5ft. 6in. gauge.
SCHEDULE 3.—600 TYRES for ROLLING STOCK.
Tenders due as follows :—
Schedule 1, 28th August, 1929.
Schedule 2, 10th September, 1929.
Schedule 3, 27th August, 1929.
Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each schedule. 2907

Applications are Invited for APPOINTMENTS as :—
1. LECTURER in MECHANICAL ENGINEERING.
2. LECTURER in CIVIL ENGINEERING.
at the Government Technical Institute, Insein, Burma.
Candidates for (1) should possess an Honours Degree in Engineering and have had experience both in teaching and in engineering work. Preference will be given to an applicant with experience in the design, construction and working of Internal Combustion Engines.
Candidates for (2) should possess an Honours Degree in Engineering of a British University and have had experience in teaching and in the design and construction of Civil Engineering Works.
Conditions for either appointment :—
Salary Rs. 1050 a month, rising by annual increments of Rs. 50 to Rs. 1250 a month, equivalent approximately to £945 per annum, rising to £1125 per annum. Agreement for five years in first instance. Free first-class passage out and home. In the event of renewal of agreement one free return passage home will be granted. Provident Fund. Strict medical examination. Age preferably about 35 years.
Full particulars and forms of application may be obtained upon request by postcard to the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 14th September, 1929. 2818

Board of Trade, STANDARDS DEPARTMENT.
A VACANCY exists for an ASSIZER, Grade II., in the Standards Department of the Board of Trade. The duties are in connection with the verification of weighing and measuring appliances, &c.
Candidates must be British subjects by birth and the sons of fathers also British-born subjects, and preference will be given to ex-Service candidates having experience in making and using instruments of precision, including fine balances.
The selected candidate will be required to serve a period of 12 months on probation in a temporary capacity at a salary of 70s. a week inclusive, after which he will be eligible for establishment in His Majesty's Civil Service at the minimum of the scale of £130 per annum, rising by annual increments of £10 to a maximum of £180 per annum plus bonus. (The present bonus of £130 per annum is £76 8s., making a total of £206 8s. per annum.) He will also be required to spend some time each year travelling in connection with the verification of standards at local Weights and Measures Offices. On these occasions he will be granted travelling expenses and the appropriate subsistence allowance.
Applications, with copies of testimonials, should be made in writing to the PRINCIPAL ESTABLISHMENT OFFICER, Board of Trade, Great George-street, London, S.W. 1, not later than 23rd August, 1929. 2877

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.
APPLICATIONS from qualified candidates are INVITED for the following POSTS :—
M/1574.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of UGANDA for the PUBLIC WORKS DEPARTMENT, for a tour of 20 to 30 months' service and possible extension. Salary, £480, rising to £600 a year by annual increments of £20, and thence rising to £720 a year by annual increments of £30. Free quarters and passages. Liberal leave on full salary. Outfit allowance of £50 on first appointment. Candidates, preferably single, 25 to 30 years of age, must have passed Sections A and B in the examination for the A.M.I.C.E. Diploma or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations. Must have had experience in the Construction and Maintenance of buildings, and preferably had training and experience in Municipal Engineer's Office. Some knowledge and experience of Bridge Construction is also desirable.
Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/1574. 2898

Department of Scientific and Industrial RESEARCH.
JUNIOR ASSISTANTS are REQUIRED at the NATIONAL PHYSICAL LABORATORY in the Metallurgy Department. Candidates should have a good Honours Degree, preferably with some research or technical experience in metallurgy.
Scale of salary £175-15-£235 per annum plus Civil Service bonus; the total pay corresponding to £175 basic is at present approximately £266. Superannuation provision will be made under the Federated Superannuation System for Universities.—Application must be made on a form to be obtained from the DIRECTOR, National Physical Laboratory, Teddington, to whom it should be returned not later than August 31st, 1929. 2821

Draughtsman, Grade II, REQUIRED for Technical Publications Work. Candidates must have good general knowledge of Aircraft and Aero-engines, and be able to prepare perspective sketches suitable for reproduction in technical handbooks and to build up perspective illustrations from workshop drawings. Preference given, other things being equal, to an ex-Service man. Salary £125 plus Civil Service bonus per year, giving a present total starting remuneration of £199 16s. on the scale £125-7s.-£150 plus bonus per year.
Write (quoting reference No. A. 963), stating age and full particulars of experience, to the CHIEF SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 2860

University of Liverpool.
FACULTY OF ENGINEERING.
DEAN: Professor G. E. SCHOLES, M.B.E., M.Sc., M.I.A.E., M.I. Mech. E.
The University awards the Degrees of B. Eng., M. Eng., D. Eng., Ph.D., and a Certificate and Diploma in Engineering.
Degree Candidates must pass an approved Matriculation Examination. Certificate Candidates must submit evidence of having received a good general education. Diploma Candidates must possess the Certificate in Engineering.
The Courses are designed for students desiring to qualify as MECHANICAL, ELECTRICAL, CIVIL or MARINE ENGINEERS, as NAVAL ARCHITECTS and METALLURGISTS or METALLURGICAL ENGINEERS. The Courses cover the subject of examination for Associate Membership of the Institutions of Civil, Mechanical, and Electrical Engineers. The Institutions named, subject to certain conditions, accept the Degree of B. Eng. in lieu of part, and in some cases the whole, of the examinations for Associate Membership. The various Departments are housed in commodious and well-equipped buildings, and provide ample facilities for research.
A prospectus of the Faculty, giving particulars of Courses and a large number of Entrance and Post-graduate Scholarships, may be had on application to the undersigned.
EDWARD CAREY,
1512 Registrar.

University of Manchester.
PHYSICS DEPARTMENT.
Full particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and Honours Degrees, will be forwarded on application to the REGISTRAR. The SESSION COMMENCES on THURSDAY, OCTOBER 3rd. 2832

University of Manchester.
DEPARTMENT OF ELECTRICAL ENGINEERING.
DEPARTMENTS OF CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING.
Full particulars of these Courses will be forwarded on application to the REGISTRAR. The SESSION COMMENCES on THURSDAY, OCTOBER 3rd. 2845

PUBLIC NOTICES

Heriot-Watt College, EDINBURGH.
FULL TIME DAY DIPLOMA COURSES.
MECHANICAL ENGINEERING
ELECTRICAL ENGINEERING
MINING and OIL ENGINEERING
APPLIED CHEMISTRY and BREWING BUILDING.
AUTUMN TERM BEGINS OCTOBER 15th.
Full particulars from the College.
J. CAMERON SMAIL, O.B.E., Principal. 2609

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY.
(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER.)
APPOINTMENT OF ASSISTANT LECTURER IN METALLURGY AND ASSAYING.
The Governing Body invites APPLICATIONS for an ASSISTANT LECTURESHIP in METALLURGY and ASSAYING in the College of Technology, with the title and status of Assistant Lecturer in the University of Manchester.
Salary £300 per annum.
Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester. The last date for the receipt of applications is Monday, 16th September, 1929.
Canvassing, either directly or indirectly, will disqualify a candidate for appointment.
B. MOUAT JONES,
2846 Principal of the College.

Leicester College of Technology.
PRINCIPAL: L. W. KERSHAW, B.Sc., A.M. Inst. C.E., F.G.S.
APPLICATIONS are INVITED for the POST of full-time LECTURER in MECHANICAL ENGINEERING SUBJECTS.
Applicants must be graduates and must have had teaching and workshop experience.
Salary in accordance with the Burnham Scale.
Application forms may be obtained from the Registrar, College of Technology, Leicester, to whom they should be returned not later than 24th August.
F. P. ARMITAGE,
2844 Director of Education.

PUBLIC NOTICES

Sunderland Education COMMITTEE.
SUNDERLAND TECHNICAL COLLEGE.
DEPARTMENT OF MECHANICAL AND CIVIL ENGINEERING.
APPLICATIONS are INVITED for the POST of full-time LECTURER in ENGINEERING. Candidates should possess an Honours Degree in Engineering, or its equivalent, and must have had works or drawing-office experience.
Salary in accordance with the Burnham Award.
Forms of application may be obtained from the Principal, the Technical College, and must be returned to the undersigned on or before Monday, 9th September, 1929, by first post.
HERBERT REED,
Chief Education Officer.
Education Offices,
15, John-street, Sunderland, Co. Durham,
12th August, 1929. 2870

Borough of Bexhill.
CORPORATION WATERWORKS.
The Corporation invite TENDERS for the LAYING and JOINTING of approx. 648 YARDS of 9in. CAST IRON WATER MAIN and 94 YARDS of 4in. CAST IRON WATER MAIN in the Borough of Bexhill.
Plans may be seen and specification, bill of quantities, and form of Tender obtained from the Water Engineer, Mr. E. Pollard, A.M.I. Mech. E., Town Hall, Bexhill-on-Sea, upon receipt of a deposit of One Guinea, which will be returned after the Council have dealt with the Tenders, to contractors who have submitted bona fide Tenders.
Sealed Tenders, endorsed "9in. Water Main," on the prescribed form, together with priced schedule, must be delivered at the Town Clerk's Office, Town Hall, Bexhill-on-Sea, not later than Noon on the 12th September, 1929.
The Council do not bind themselves to accept the lowest or any Tender.
S. J. TAYLOR,
Town Clerk.
Town Hall, Bexhill,
13th August, 1929. 2884

Borough of Bexhill.
CORPORATION WATERWORKS.
The Corporation invite TENDERS for the SUPPLY of approx. 648 YARDS of 9in., 160 YARDS of 6in., and 600 YARDS of 4in. CAST IRON PIPES, and approximately THREE TONS of SPECIALS.
Specification, schedule, and form of Tender may be obtained from the Water Engineer, Mr. E. Pollard, A.M.I. Mech. E., Town Hall, Bexhill-on-Sea.
Sealed Tenders, endorsed "Tender for 9in. Water Pipes," must be delivered at the Town Clerk's Office, Town Hall, Bexhill-on-Sea, not later than Noon on the 12th September, 1929.
The Council do not bind themselves to accept the lowest or any Tender.
S. J. TAYLOR,
Town Clerk.
Town Hall, Bexhill,
13th August, 1929. 2885

Borough of Bexhill.
CORPORATION WATERWORKS.
The Corporation invite TENDERS for the SUPPLY of :—
48 FIRE HYDRANTS.
16 SLUICE VALVES.
And SURFACE BOXES for same.
Specification, schedule and form of Tender may be obtained from the Water Engineer, Mr. E. Pollard, A.M.I. Mech. E., Town Hall, Bexhill-on-Sea.
Sealed Tenders, endorsed "Tender for Hydrants and Valves," must be delivered at the Town Clerk's Office, Town Hall, Bexhill-on-Sea, not later than Noon on the 12th September, 1929.
The Council do not bind themselves to accept the lowest or any Tender.
S. J. TAYLOR,
Town Clerk.
Town Hall, Bexhill,
13th August, 1929. 2886

NORTHERN INDIA
ENGINEERING DEVELOPMENT.
Many huge projects are completed, others are under construction, and still more are under consideration. When tendering, remember that we have handled, inter alia, all the material for the Lloyd Barrage, the largest irrigation scheme in the world, and that WE HAVE THE EXPERIENCE to enable us to quote you the most favourable terms for CLEARING and DESPATCHING up country any quantity of material to any site required.
For full particulars apply, EASTERN EXPRESS CO., Ltd., Karachi; or to Messrs. FORBES, FORBES, CAMPBELL and CO., Ltd. (Managing Agents), 9, King William-street, London, E.C. 4. F 5809

PUBLIC NOTICES (continued) Page 2.
SITUATIONS OPEN, Page 2.
SITUATIONS WANTED, Pages 2 and 4.
AUCTIONS, Page 96.
PARTNERSHIPS, Page 4.
MACHINERY, &c., WANTED, Page 4.
BUSINESSES and PREMISES (For Sale, etc.). Page 96.
EDUCATIONAL, Page 4.
PATENTS, Page 96.
MISCELLANEOUS, Page 4.
AGENCIES, Page 4.
FOR SALE, Page 96.
WORK WANTED, Page 4.
FOR HIRE, Page 4.

For Advertisement Rates see Leader Page.

PUBLIC NOTICES

County Borough of Smethwick.

PROPOSED BATHS, BEARWOOD.
HEATING AND FILTRATION.
TO HEATING ENGINEERS.

The Estates Committee is prepared to consider QUOTATIONS from reputable firms of Heating Engineers for the SUPPLY and INSTALLATION of BOILERS, PUMPS, MOTORS, PIPING, and the WHOLE of the PLANT REQUIRED in connection with the HEATING of the SWIMMING BATHS WATER, HOT WATER SUPPLY to SLIPPER BATHS, &c., and the HEATING of the BUILDING in connection with the above scheme.

Prices will be considered for schemes including boilers on the high-pressure or low-pressure system.

TO FILTRATION ENGINEERS.

The Committee is also prepared to consider QUOTATIONS for the SUPPLY and INSTALLATION of a COMPLETE FILTRATION PLANT to deal with the Swimming Baths Water.

Firms desiring to tender for either plant should communicate at once with the undersigned, enclosing deposit of £5, when plans and particulars will be forwarded.

Separate Tenders are required for the Heating and Filtration Plant, and must reach me not later than first post on Tuesday, September 10th, 1929.

ROLAND FLETCHER,
Assoc. M. Inst. C.E.,
Borough Engineer and Surveyor.

Borough Surveyor's Department,
Council House, Smethwick.
13th August, 1929. 2903

City of Birmingham.

ELECTRIC SUPPLY DEPARTMENT.
MACHINE TOOLS AND WORKSHOP EQUIPMENT—HAMS HALL STATION.

The Electric Supply Department of the Birmingham Corporation invite TENDERS for the SUPPLY, DELIVERY and ERECTION of MACHINE TOOLS and WORKSHOP EQUIPMENT, required for the Engineering Workshop at the Hams Hall Power Station.

Specifications, drawings, conditions of contract and forms of Tender may be obtained on application to the undersigned.

Tenders, which must be under a sealed cover and endorsed "Tender for Machine Tools," to be addressed to the undersigned and delivered not later than Twelve Noon on the 26th August, 1929.

E. J. JENNINGS,
Secretary.

14, Dale End, Birmingham,
31st July, 1929. 2806

County Mental Hospital,

RAINHILL.

The Committee invite FIRMS of HEATING and HOT WATER ENGINEERS to SUBMIT a SCHEME for CENTRALISED HEATING and CONNECTING UP to existing HOT WATER SERVICE at the Annexe Buildings of this Mental Hospital, along with a TENDER for CARRYING OUT the WORK.

Plans of the buildings may be seen at the Engineer's office by appointment, and Tenders, along with detailed scheme, must be delivered at this office not later than the 1st October, 1929.

It is understood the Committee will not be under any obligation to firms whose Scheme and Tender is not accepted.

W. E. BIXTER,
Clerk and Steward.

9th August, 1929. 2854

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF FOUR WATER-TUBE BOILERS, SETTINGS, SUPERHEATERS, ECONOMISERS, PREHEATERS, PIPING, FEED PUMPS, COAL AND ASH HANDLING PLANT, &c., AT DEPTFORD PUMPING STATION.

The Metropolitan Water Board invite TENDERS for the SUPPLY and ERECTION of FOUR WATER-TUBE BOILERS, SETTINGS, SUPERHEATERS, ECONOMISERS, PREHEATERS, PIPING, FEED PUMPS, COAL AND ASH HANDLING PLANT, &c., at their Deptford Pumping Station, Brookmill-road, London, S.E. 8.

Forms of Tender, conditions of contract, specification and drawings may be inspected without payment of a fee at the Offices of the Board, Chief Engineer's Department (Room 173), on and after Wednesday, 21st August, 1929.

Contractors desirous of tendering may obtain the necessary documents from the Chief Engineer on production of an official receipt for the sum of Three Guineas, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender, accompanied by all the above-named documents and drawings. Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Boilers, Deptford," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, 30th September, 1929.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
13th August, 1929. 2878

South Indian Railway Company,

LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of—

1. STEEL FISHPLATES.
2. PIG IRON.
3. CRANK and STRAIGHT AXLES.
4. CHECK RAILS, DISTANCE BLOCKS and BOLTS, NUTS and WASHERS.
5. COILED STEEL KEYS.
6. METALS.
7. SPRING STEEL.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Steel Fishplates," or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, the 30th August, 1929.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of Specification No. 1, of 5s. for each copy of Specifications Nos. 2, 3, 4, 5 and 6, and of 2s. 6d. for each copy of Specification No. 7.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

H. J. MORRIS,
for Managing Director.

91, Petty France,
Westminster, S.W. 1,
14th August, 1929. 2897

PERTH (W.A.) POWER-HOUSE EXTENSION.

The Agent-General for Western Australia,

on behalf of the Government of Western Australia, is prepared to receive TENDERS for the SUPPLY, DELIVERY, and ERECTION at Perth of the following :—

(A) COMPLETE BOILER-HOUSE EQUIPMENT.
(B) ONE 12,500-kW TURBO-GENERATOR and CONDENSING PLANT.

Tenders, which must be in duplicate, shall be lodged at the office of the AGENT-GENERAL, Savoy House, Strand, London, W.C. 2, not later than 2.30 p.m. on Friday, 29th November, 1929.

The duplicate Tenders shall be lodged in a separate envelope clearly marked "Duplicate."

A fee of £1 1s. will be charged for each copy of each specification, and sums paid for specifications WILL NOT BE RETURNED in any circumstances whatever. 2862

PUBLIC NOTICES

Indian State Railways.

THREE ASSISTANT ENGINEERS are REQUIRED for service in the Mechanical Engineering Department of the Indian State Railways.

Age not more than 30 years.

QUALIFICATIONS.—Candidates should have received a good general and technical education and have passed the Associate Membership Examination of the Institution of Civil Engineers, or hold a degree or diploma granting exemption from Sections "A" and "B" of that examination ; should have served at least four years as pupil or apprentice in the Locomotive Workshops of a British Railway Company or firm of Locomotive Builders of repute, and at least one year in the drawing-office. They should possess an intimate knowledge of the planning, progressing and costing methods adopted in workshops of up-to-date commercial firms.

SALARY.—Initial salary will be fixed according to the age, qualifications and experience of the candidate. Salary payable from date of landing in India, subject to rules in force. Leave, Provident Fund and gratuity in accordance with the rules applicable to officers of the Indian State Railways. Agreement for three years in the first instance, but service to be extensible beyond that period with the consent of both parties concerned.

A first-class passage to India will be provided on appointment.

Application must be made by letter only, and all applicants must state their age, whether married or single, and give full particulars (in chronological order) of their education, training and subsequent experience, stating the names of railways or contractors by whom they have been employed and giving details of the work employed upon, with dates. Details should also be given of any previous experience abroad, together with copy of leaving certificate.

Applications, which should be accompanied by copies only of testimonials, must be addressed to the undersigned not later than 31st August, 1929.

Messrs. RENDEL, PALMER & TRITTON,
12/15, Dartmouth-street, Westminster, S.W. 1.
2849

Municipality of George Town,

PENANG, STRAITS SETTLEMENTS.
WATER ENGINEER'S DEPARTMENT.
APPOINTMENT OF ASSISTANT WATER ENGINEER.
ADVERTISEMENT.

The Municipal Commissioners of George Town, Penang, REQUIRE a CHARTERED CIVIL ENGINEER ASSISTANT for their Water Department, aged 28-32 years and preferably unmarried, the appointment being in the first instance on a three years' agreement, with possible extension on the permanent staff.

Applicants must have had a good technical education and a regular training as pupil and Assistant with a County Engineer or a Civil Engineer in private practice, preferably in an office engaged on works of Water Supply. Candidates must have had at least five years' all-round experience in Water Supply, and the selected candidate must be prepared to work under the Water Engineer or Deputy Water Engineer on maintenance and/or construction and also on anti-malarial work. Experience in the carrying out of work by direct labour is desirable.

Applicants must be corporate members of the Institution of Civil Engineers.

Salary, 7200 dollars for the first year, 7500 dollars for the second year, and 7800 dollars for the third year of the agreement, and rising, in the event of service being continued after expiry of the agreement, by annual increments of 300 dollars to an ultimate maximum of 10,200 dollars per annum. The salary will be paid monthly in dollars, the currency of the Colony, the value of the dollar being 2s. 4d. sterling. In addition there is, at present, a temporary allowance of 10 per cent. on the salary for unmarried men. The pay of the appointment at the above rate for first year including temporary allowance would be £924. An allowance for the maintenance of a motor car when on duty will be granted. Free first-class passage will be provided, with half-pay during voyage out and home. The selected candidate must pass an approved medical examination.

Eight months' leave, on full pay, with passage paid, is usually granted after four years' service, if the appointment be continued for that period and the officer intends to return to Penang.

There is a generous Superannuation and Provident Fund for Municipal Officers.

George Town is situated on the coast within three miles of the Penang Hill Railway, which runs up to the Hill Station, 2400ft. above sea level.

Applications, stating whether married or single and giving age and birthplace, with full details of education, training and experience generally, and referring particularly to the qualifications mentioned above and accompanied by copies (not originals) of testimonials, to be lodged with Messrs. PEIRCE and WILLIAMS, MM. Inst. C.E., 64, Victoria-street, London, S.W. 1, Agents for the Commissioners, not later than Friday, 23rd August. Further particulars, if desired, can be obtained from the Agents. 2892

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED,
CHEMIST OR ENGINEER
OR
CHEMICAL ENGINEER,

Having first-class experience in the manufacture of Silk by the Dry (so-called Acetate) Process.

Those having only experimental experience need not apply, as only a practical man is required who is capable (based on actual experience) of supervising a large plant.

Particulars should be given of the daily production of silk spun, and how many spinning machines installed or operated and how many spindles per machine, so as to give some indication of experience.

Salary £400 to £900 per annum or more, according to experience.

Write, Box A. 757, Willing's, 86, Strand, W.C. 2. 2746 A

WANTED, ENGINEER Who Has Been engaged in the Erection and Operation of CELLULOSE ACETATE PLANT.

Particulars required about size of plant.

High salary offered to the right man.

Write, Box C. 759, Willing's, 86, Strand, W.C. 2. 2745 A

WANTED, ENGINEER, Experienced in Reinforced Concrete Design and Construction for Road Work in South America. Spanish desirable.—Address full particulars, 2891, The Engineer Office. 2891 A

WANTED for an English Firm of Metal Merchants and Engineers in Calcutta, a TRAVELLING REPRESENTATIVE. Five years' agreement ; must be unmarried, age 24 to 27. Commencing salary Rs. 500 per month.—Write, with copies of testimonials and photograph if possible, to Z.X. 885, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 2874 A

WANTED, TWO or THREE ENGINEERS (25 to 35), with good general experience, capable of taking complete charge of contracts. State full particulars.—Address, 2859, The Engineer Office. 2853 A

SITUATIONS OPEN (continued)

ASSISTANT ENGINEERS WANTED, with Experience of Contractors' Offices.—Apply, EDMUND NUTTALL, SONS and CO., Ltd., Trafford Park, Manchester. 2866 A

CHIEF RATE FIXER for Machining, Fitting and Tinsmithing in Aero-engine Factory. Must have had wide experience on best-class work. Permanent position to suitable man.—Address, giving fullest details of experience and stating age and salary required, 2804, The Engineer Office. 2804 A

COMBUSTION ENGINEER WANTED ; First-class man with extensive experience in design and application both of Solid and Pulverised Fuel Installations.—Write, stating age, experience, and salary required, to Box 98, Sells' Advertising Offices, Fleet-street, E.C. 4. 2890 A

ELECTRICAL and MECHANICAL ENGINEER for position as CHIEF PRODUCTION MANAGER and ENGINEER in large Lancashire factory working on mass production and continuous process lines. Applicant must be good organiser and have previously held responsible position. Age 35 to 45. Commencing salary £750 to £1000 per annum to right man. No reply to application to be expected for about one month.—Address application, with full particulars and copies of testimonials, 2865, The Engineer Office. 2865 A

ENGINEER SALESMAN REQUIRED, with Experience and knowledge of the Midlands, to be attached to London office by important Non-ferrous Manufacturers.

Address, stating full particulars, age, and salary, 2900, The Engineer Office. 2900 A

INDIA.—REQUIRED by British Firm of Engineers, DRAUGHTSMAN, accustomed to Roof, Bridge, and Structural Steel Work, able to work out stresses and prepare designs, estimates, and detail drawings. Must be a bachelor, age 22 to 25.—Apply, stating age and particulars of experience, to Z.B. 910, care Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 3. 2895 A

PHYSICAL CHEMIST WANTED in the Metallurgical Research Department of a large industrial firm near London. A knowledge of Metallurgical Chemistry and Metallography is desirable ; some works experience preferred, but not essential. Send full details of age, education, experience, references, and salary required before August 23rd.—Address, 2881, The Engineer Office. 2881 A

REQUIRED for Central Power Station, Chile, Competent ENGINEER, bachelor, first-class specialist Diesel Engines and Electricity.—Write full particulars, age, qualifications, &c., to Box B. S. J., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 2861 A

SEVERAL JUNIOR ENGINEERS REQUIRED, willing to go to any country abroad to Advise Agents and Customers in Purchase, Installation and Maintenance of Internal Combustion Engines and other Engineering Plant. Applicants should have had a good technical training at a recognised Engineering College and must have served a full workshop apprenticeship.—Address, giving full particulars of education and experience, 2883, The Engineer Office. 2883 A

SURVEYOR, South African Rand Experience Preferred, and who must be first-class Draughtsman. WANTED IMMEDIATELY for Gold Mine on Gold Coast. Salary £720 ; 12 months' agreement, first-class passage out and home ; must pass medical examination and be prepared sail 4th September.—Write, stating age (minimum 30), qualifications, full details experience, with copies testimonials, to B. M., c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 2858 A

THOROUGHLY Experienced RATE FIXER REQUIRED for modern Engineering Works situated in the North Midlands. Those only with knowledge of up-to-date methods need apply. Excellent opportunity for the right man. Replies will be treated in strict confidence.—Address, stating age, full particulars of experience, and salary required, 2879, The Engineer Office. 2879 A

£1500 to £2000 p.a., According to Experience, for COMMERCIAL ENGINEER to take complete charge Government contracts for an old-established firm. Work comprises tendering, sub-contracting where necessary, erection on site and handing over after test the equipment and plant manufactured. Only applicants having sound electrical and mechanical experience should apply ; preference will be given to those having Automatic Telephone experience.—Address in strict confidence, 2830, The Engineer Office. 2830 A

WANTED, ENGINEERING DRAUGHTSMAN, Experienced Mechanical Handling Plant and Structures. Initiative and sound technical training essential. District, North Midlands. State age, experience, and salary required.—Address, 2825, The Engineer Office. 2825 A

WANTED, SENIOR DRAUGHTSMAN, with Machine Tool experience, for Midlands. State full experience, age and salary required.—Address, 2906, The Engineer Office. 2906 A

CONSTRUCTIONAL STEEL WORK DRAUGHTSMAN REQUIRED, with thorough knowledge London Building Acts essential.—Address, giving age, experience, qualifications, and salary required, 2882, The Engineer Office. 2882 A

DRAUGHTSMAN, First-class Designer, REQUIRED for Structural Steel Work in London office.—Apply in confidence, stating experience, age, and salary required, to A. and J. MAIN and CO., Ltd., Australia House, Strand, London, W.C. 2. 2869 A

DRAUGHTSMAN, Good Senior, with Experience of large A.C. and D.C. Generators.—Address, stating qualifications, references, age, salary, and earliest date can commence, 2850, The Engineer Office. 2850 A

DRAUGHTSMAN (JUNIOR), with General Rubber Works experience, for Edinburgh district.—Address, giving full particulars experience, age and wage required, 2758, The Engineer Office. 2758 A

DRAUGHTSMAN, Mechanical - Electrical, with general experience of Electrical Apparatus.—Address, stating age, experience, and salary required, 2802, The Engineer Office. 2802 A

DRAUGHTSMAN or ENGINEER, Accustomed to estimating for General Engineering Work, WANTED by North-East Coast Firm.—Write, giving fully particulars of experience, age, salary required, Z.R. 902, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 2875 A

DRAUGHTSMAN REQUIRED, Experienced in High-speed Engine Work, Design and Details. Must have had first-class experience in the most modern engines for generating plants for marine work.—Address, stating age, experience, and salary required, 2857, The Engineer Office. 2857 A

DRAUGHTSMAN REQUIRED for Leading Automobile Concern, Coventry district. Give fullest particulars, including experience, age, and salary required.—Address, 2870, The Engineer Office. 2870 A

DRAUGHTSMAN REQUIRED, Experienced in Carbonising Plant and Coal Handling. Progressive position.—Address, stating age, experience, and salary required, 2868, The Engineer Office. 2868 A

DRAUGHTSMEN REQUIRED for Detailing Structural Steel Work, London office. Permanency for the right men.—Address, stating age, experience, and salary required, P6095, The Engineer Office. P6095 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN REQUIRED, London District, age about 25, good knowledge of pattern shop, foundry and machine shop practice, quick at figures and conversant with Drawing Office routine.—Address, stating age, experience and salary required, to P6110, The Engineer Office. P6110 A

DRAUGHTSMEN. — DRAUGHTSMEN WANTED, skilled in Pipe Arrangement Work, Turbine Details and Water-tube Boilers. Only those conversant with present destroyer practice need apply.—Write, "D. W.," c/o Street's, 6, Gracechurch-street, E.C. 3. 2871 A

DRAUGHTSMEN.—The BRITISH THOMSON-HOUSTON CO., Ltd., Rugby, has VACANCIES for MECHANICAL and ELECTRICAL DRAUGHTSMEN.—Apply, stating age, experience, salary required, to MANAGER, Drawing-offices, B.T.H. Co., Ltd., Rugby. 2803 A

DRAUGHTSMAN WANTED with Experience in Pumping Machinery and Auxiliary Plant.—Address, stating experience, age and salary required, to 2817, The Engineer Office. 2817 A

DRAUGHTSMEN.—TWO First-class MEN REQUIRED, used to detailing Steel-frame Buildings, Bridges, and General Constructional Work.—Apply, stating age, experience, and salary required, to BRAITHWAITE and CO., ENGINEERS, Ltd., West Bromwich. 2901 A

DRAUGHTSMAN, with Good Experience in Mechanical Design of Large D.C. Generators and Water-driven Alternators. Able to undertake responsibility for mechanical design and supervise work of assistants.—Address, stating experience, age, and salary expected, with copies of three references, 2893, The Engineer Office. 2893 A

LEADING DRAUGHTSMAN REQUIRED for London Office with good knowledge of Steel Works, Furnaces and Gas Producer Plant.—Reply by letter, to STEIN and ATKINSON, 47, Victoria-street, London, S.W. 1, stating age, qualifications, salary required, and when at liberty. 2905 A

LEADING DRAUGHTSMAN REQUIRED. Salary £400 year to right man. Experienced General Mechanical Work, particularly all types Light Conveyors and Steel Work. Excellent prospects, permanent situation.—Address, 2902, The Engineer Office. 2902 A

SHIP DRAUGHTSMEN. — SHIP DRAUGHTSMEN REQUIRED ; preference given to those with some experience in Destroyer and Shallow-draught Vessels.—Write, "S. R.," c/o Street's, 6, Gracechurch-street, E.C. 3. 2872 A

STRUCTURAL STEEL DRAUGHTSMEN REQUIRED by leading London Constructional Engineers. Must be conversant with London practice.—Address, stating age, experience, and salary required, P6084, The Engineer Office. P6084 A

JOHN HETHERINGTON and SONS, Limited, have VACANCIES for several MACHINE TOOL DRAUGHTSMEN. Applications are invited from men with good all-round experience of high-class Heavy Machine Tool work ; must be capable and efficient designers ; ability will be the first consideration. ANCOATS WORKS, MANCHESTER. 2840 A

JUNIOR CIVIL ENGINEERING DRAUGHTSMAN REQUIRED temporarily in Railway Engineer's Office in London, with experience in General Constructional and Building Work. Knowledge of surveying work an advantage.—Address, stating age, experience, and salary required, 2851, The Engineer Office. 2851 A

JUNIOR DRAUGHTSMAN REQUIRED by Progressive Lift Firm in Midlands. Previous experience preferred, but not essential.—Address, stating age, experience, and wage required, 2889, The Engineer Office. 2889 A

JUNIOR DRAUGHTSMAN REQUIRED in London area. Must have had previous experience of Constructional Steel Work Details.—Address, stating salary required, age, and giving details of previous training, 2880, The Engineer Office. 2880 A

LEADING DRAUGHTSMAN for Steam Turbine Work. Must be capable of all detail designing from engineers' data ; only experienced senior men need apply.—Address applications in confidence, with copies of references, stating experience, salary required, age, 2894, The Engineer Office. 2894 A

ONE or TWO ENGINEERS or DRAUGHTSMEN, with good experience of Blast-furnace Construction, Erection, &c., WANTED for a firm on the North-East Coast.—Write, giving full particulars, age, and salary required, Z.P. 901, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 2876 A

REQUIRED for English Engineering Works in India, an ENGINEER DRAUGHTSMAN, with good practical and theoretical training in mechanical engineering, with experience particularly in Pumps and Oil Engines. Must be a bachelor. Age 23 to 25.—Apply stating age and giving full particulars, to Z.C. 911, care Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 3. 2896 A

STRUCTURAL ENGINEERING DRAUGHTSMAN WANTED AT ONCE for Southampton, accustomed design and estimating. State age, experience, and salary required.—Address, P6094, The Engineer Office. P6094 A

TOOL DESIGNERS, Competent Men with Press Tool experience preferred.—Write details of experience, &c., to EMPLOYMENT DEPT., Pressed Steel Co., Cowley, Oxford. 2899 A

BRICKS AND TILES.—Experienced FOREMAN REQUIRED to manage Tile Works in India. Up to date practical knowledge of the manufacture of Roofing and Flooring Tiles and Bricks essential, also experience of continuous Kilns and Dryers. Must be able to supervise native labour. Applicants should be physically fit ; age not over 35. Free quarters, passage and outfit allowance. Write, giving full particulars of experience.—Address, 2793, The Engineer Office. 2793 A

SITUATIONS WANTED

CIVIL ENGINEER, B.Sc., A.M.I.C.E., 25 Years' experience railway survey and construction, also Irrigation in North America, Spain, South Africa, West Africa and India, will UNDERTAKE WORK in executive capacity in any part of the world. Specialised in tacheometer survey ; knowledge of Hindustani and Spanish.—Address, P6068, The Engineer Office. P6068 B

COST CLERK (Age 25), Student Member of I.C.W.A., DESIRES progressive POSITION. At present assistant cost clerk to important motor car manufacturers. Keen, adaptable and fond of work. Thorough knowledge of accountancy, works accounts and factory routine.—BEEWER, 241, Victoria-road, N. 22. P6100 B

ENGINEER (26), 2 Years' University Training, extensive practical experience, works, D.O., and commercial, general mechanical, steel work, combustion and hardware, DESIRES SALES POSITION with prospects.—Address, P6108, The Engineer Office. P6108 B

For continuation of Small Advertisements see page 4.

A Seven-Day Journal

Scrap for Steel Making.

In May last the President of the Board of Trade appointed a Committee to inquire into the position as to the supply of scrap for steel making in the United Kingdom. The Chairman was Sir Roy Wilson, and the members included Sir Henry Fowler and Sir Alfred Herbert, with Mr. C. K. Hobson, of the Board of Trade, as the Secretary. The Committee has been in abeyance for some time, owing to the enforced retirement of Sir Roy Wilson on medical advice. It is now announced that the Government has decided to merge the question of the supply of scrap into the larger investigation concerning the iron and steel industries generally, which is being dealt with by a Sub-committee of the Committee of Civil Research, recently appointed by the Prime Minister. As already mentioned in our Journal note of August 2nd, the Committee will be presided over by the Lord Chancellor, Lord Sankey, and its members will include Mr. Thomas Shaw, Sir Cecil Budd, Mr. T. C. Cramp, and Sir William Plender. The joint Secretaries are Mr. A. F. Hemming and Mr. W. Palmer, to whom any communications should be made at 2, Whitehall-gardens, London, S.W. 1. For some time past there has been a marked shortage of scrap for steel making in this country, which has been largely brought about by the heavy sale of scrap to other countries. In this connection, it is of interest to record that practically the whole of the scrap material from the ex-German battleships and cruisers raised by Cox and Danks, Ltd., at Scapa Flow has found its way to America, Germany, and Scandinavia, in which countries there appears to be a keen demand for the alloy steels and other special metals employed in naval construction.

The Schneider Trophy Race.

On Monday of this week, August 12th, the Air Ministry kindly afforded us facilities to visit the Royal Air Force base at Calshot, and to inspect the first of the four high-speed seaplanes, which have been specially designed and built for the forthcoming Schneider Trophy Race, to be flown on Saturday, September 7th. We also had an opportunity of meeting the members of the British High-speed Flight Team, which was formed at Felixstowe, and some months ago transferred to Calshot for practice. In the race Great Britain will be represented by three high-speed seaplanes manned by Service officers. The machine which was available for inspection on Monday was the first of the four to be delivered, and it was afterwards taken out for a successful short trial flight by Squadron Leader A. H. Orlebar. It is one of the two machines built by the Supermarine Aviation Works, Ltd., at Southampton, to the design of Mr. R. J. Mitchell. It follows generally the design of the "S 5" seaplane of last year, but embodies notable improvements. The "S 6" is an all-metal low-wing monoplane, with twin floats. The fuel tanks are arranged within the floats, and a new type of wing surface radiator is utilised for cooling the engine circulating water. The oil tank is in the fin of the seaplane, and there are oil coolers in the metal fuselage. The front float supports have been moved forward to provide a support for the engine mounting, thereby saving weight. The engine is a Rolls-Royce "R" type, twelve-cylinder, supercharged motor of an entirely new design, giving a large increase in power. The cylinders are arranged in two banks of six placed at 60 deg. to each other, and the whole design is such that minimum frontal area is obtained with a good streamline effect. The propellers were constructed under the Fairey-Reid patents by the builders and the Fairey Aviation Company, Ltd., of Hayes. During the week several trials were made with the Supermarine Rolls Royce seaplane with, it is understood, very satisfactory results. On Wednesday, when returning after a full-power trial, one of the floats was slightly damaged. The second "S 6" machine will shortly be delivered, and the first of the two "Gloster Napier 6" monoplanes, built by the Gloster Aircraft Company, Ltd., of Cheltenham and equipped with Napier "Lion VII.D" racing engines is to be delivered and will probably undergo preliminary tests at the end of this week.

An Aeronautical Research Report.

Several important matters related to the improvement of aeroplane performance are dealt with in the recently issued report of the Aeronautical Research Committee for 1928 to 1929. Work on the reduction of drag is proceeding, and a simple means has been devised for decreasing the drag of aeroplanes which are fitted with air-cooled engines. Preliminary experiments point to the possibility of reducing the drag which results from the interference of different parts of the machine. On the questions of stability and control, it is suggested that an important forward step will be the designing of greatly simplified recording apparatus. No theoretical or research or wind tunnel experiments have been carried out on gyroplanes. The construction of a gyroplane having a more rigid type of wing construction with single articulation has been completed, but so far the flying tests made with this machine have not been fully successful. The performance of the doubly articulated gyroplane of the Cierva-Autogyro type has been measured, but the report expresses the opinion that, except for special purposes, this type of aircraft will not compete seriously with the ordinary type of aeroplane on account of the smaller rate of climb. A sub-committee has been formed to deal with the question of noise from aircraft, and researches are contemplated which will be directed towards the reduction of noise, both from the point of view of passengers travelling in civil aircraft, and persons living in the neighbourhood of aerodromes. Certain special types of instruments for the measurement of aircraft noise are being designed, and will be used in special experimental work relating to civil aircraft.

The Flotilla Leader Codrington.

On Thursday of last week, August 8th, a large company of Admiralty officials and guests attended the launch of the new flotilla leader "Codrington," which is being constructed by Swan, Hunter and Wigham Richardson, Ltd., of Wallsend-on-Tyne, and engined by the Wallsend Slipway and Engineering Company, Ltd. The new vessel is of special interest, as she is the first flotilla leader to be built for the Royal Navy since the conclusion of the war. In her design there has been incorporated improvements which have been derived from war service. Her dimensions are somewhat in excess of those of modern destroyers, and her displacement, when fully equipped for sea, is expected to be about 2000 tons. Her main propelling machinery comprises a twin-screw arrangement of combined impulse and reaction turbines of the Parsons type driving the propellers through single-reduction gearing. Oil-fired water-tube boilers are fitted, and they will work under forced draught in closed stokeholds. The armament will include five 4·7in. guns and two sets of multiple torpedo tubes. The new destroyer is the first ship in the Royal Navy to carry the name "Codrington," and is so named after Admiral Sir Edward Codrington, who served from 1783 to 1851, and took part in several notable engagements. The naming ceremony on the launch last week was performed by Lady Codrington, the wife of Lieut. Sir Alfred E. Codrington, K.C.B., who is a grandson of the famous Admiral. On the same day the "Codrington" was launched, John Brown and Co., Ltd., of Clydebank, launched the torpedo-boat destroyer "Acasta," which has been built to the order of the Admiralty, and is one of four of the 1927 destroyer class of about 1550 tons displacement which are being built at Clydebank.

Edinburgh and the Electricity Scheme.

Some interesting facts concerning the Edinburgh Corporation electricity undertaking and the Central Scotland Electricity Scheme have recently been published by Mr. Edwin Seddon, the Corporation's chief electrical engineer, who states that when the Electricity Board takes over the Portobello station next year the maximum rating of the plant will be 117,500 kilowatts. For the purpose of receiving power from the station at 6600 volts, the Central Board is preparing to erect a sub-station on ground between High-street and Baileyfield-road, Portobello. By means of transformers the pressure will be raised to 132,000 volts, which, as everyone knows, is the standard pressure for the "Grid" interconnecting lines. From the Portobello station two sets of three transmission lines will be carried on towers of lattice steel construction. The average span between the towers will be about 900ft. Each set of three conductors will be capable of carrying 50,000 kilowatts. The lines, mounted on double-line towers, will run from the Portobello station past the City of Edinburgh by the following route:—Duddingston, Gilmerton, Burdiehouse, Fairmilehead, South Colinton, and Juniper Green, on to Camps, where the two lines will divide, one going south to Motherwell to meet the Clyde Valley Company's power lines and one to the north to Bonnybridge, where it will meet the main line between Glasgow and Dundee, the Forth being crossed near Kincardine Ferry. It must not be assumed, Mr. Seddon points out, that these lines can be tapped for every village *en route*, as the cost of making a suitable connection would be in the neighbourhood of £40,000.

New Aircraft Records.

On Thursday of last week, August 8th, the German airship "Graf Zeppelin" left Lakehurst, New Jersey, at 12.40 a.m., and she was favoured with a following wind and good weather. She was sighted over Lake Constance at 12.30 p.m. on Saturday, and landed at Friedrichshafen shortly afterwards, making a record crossing in 55½ hours. The time taken was 14½ hours less than that required on the occasion of the return voyage in October last. The examination of her machinery showed that the new crank shafts fitted to the engines were in excellent condition, and preparations were at once began for the round-the-world flight, which is to begin this week. On Friday afternoon, August 9th, the Duchess of Bedford, accompanied by Captain C. D. Barnard and Mr. R. F. Little, arrived at Croydon Aerodrome at 5.30 p.m. in the Fokker monoplane "The Spider," which set up two new flight records for the journey between Britain and India. The Duchess left Lympne Aerodrome on the morning of Friday, August 2nd, and reached Karachi on the Monday following. She began the return flight to England on Tuesday, August 6th, and made the trip in the record time of 46 hours. The actual flying time for the outward journey was 42½ hours, and the total of 88½ hours is a record for the return flight. British competitors also occupied leading places in the International Light Aeroplane Challenge Cup Race round Europe. The first competitors, including the two British pilots Miss Spooner and Captain Brand, left Orly Aerodrome, Paris, at 9.35 on Wednesday, August 7th, and after completing the scheduled course returned to the starting place on Wednesday last, August 14th. Both Miss Spooner and Captain Broad flew De Havilland Gipsy Moth machines, and they both arrived at Orly from Brussels two minutes ahead of the scheduled time, crossing the line just after 3 p.m. The winners are to be decided by a somewhat complicated system of points.

The Canadian Pacific Liner Empress of Canada.

The Canadian Pacific Railway Company's liner "Empress of Canada," which has been re-engined and reconditioned by the Fairfield Shipbuilding and Engineering Company, Ltd., of Govan, Glasgow, recently underwent successful trials on the Firth of Clyde, and she will shortly leave Glasgow for Southampton, from which port she is scheduled to sail on August 28th. She was built at the Fairfield yards in 1922, and was originally equipped with 21,000 S.H.P. double-reduction geared turbines, giving her a speed of over 20 knots. To give her a speed similar to that of the new C.P.R. liner "Empress of Japan," which is now under construction at Fairfields, it was decided last year to install new Parsons single-reduction geared turbines, along with Weir regenerative condensers, and to supplement the existing turbine-driven generating sets with oil engine driven generators, which work was recently completed. At the same time the boilers were fitted with smoke tube superheaters and stage feed heating was added. The designed output of the new machinery is about 26,000 S.H.P. at 120 r.p.m. in continuous service, with a maximum overload rating of 29,000 S.H.P. if required. New propellers have also been fitted, and the reconditioned liner will now, as before, be the fastest in the company's North Pacific service.

The Wolverhampton Electricity Undertaking.

The satisfactory working of the Wolverhampton Corporation electricity department during the present year was referred to by Alderman Furniss at a recent meeting of the Wolverhampton Town Council. Although the Corporation lost the sale of about ten million units per annum to the Midland Power Company by taking over a part of its area, the increase in units sold was excellent. The actual turnover for the sale of energy has now reached £280,000 per annum. The chief expenditure, Alderman Furniss explained, was in respect of the purchase of energy, which had increased, but other working costs were the same. The trading results had been good, and the Corporation had been able to meet items of a capital nature out of revenue which were previously met out of reserve.

The Design of Steel Structures.

Arrangements have now been made by the Department of Scientific and Industrial Research for an important investigation into the design of steel structures and the application of modern theory of structures, and it is announced that the work will begin in the autumn. A Committee has been appointed under the chairmanship of Sir Clement Hindley, and it will include representatives of the Institution of Civil Engineers, the recently formed British Steelwork Association, and nominees of the Department of Scientific and Industrial Research. The terms of reference are:—(1) To review present methods and regulations for the design of steel structures, including bridges; (2) to investigate the application of modern theory of structures to the design of steel structures, including bridges, and to make recommendations for the translation to practice of such of the results as would appear to lead to more efficient and economical design. The plan will include full scale experimental work, for which facilities are to be offered by members of the British Steelwork Association, an organisation which includes practically all the makers and rollers of British steel, and other work will be done at the Building Research Station, and at various Universities. The Director of Building Research is to act as an executive officer to the Committee, with a view to facilitating the carrying out of the experimental work. The investigation to be made is a very thorough one, and will, it is anticipated, extend over several years. The British Steelwork Association will bear half the cost of the inquiry, and it has offered to contribute the sum of £2000 for five years. The Department of Scientific and Industrial Research, after consultation with the Institution of Civil Engineers, has agreed to bear the other half of the cost.

RECLAMATION OF THE ZUYDER ZEE

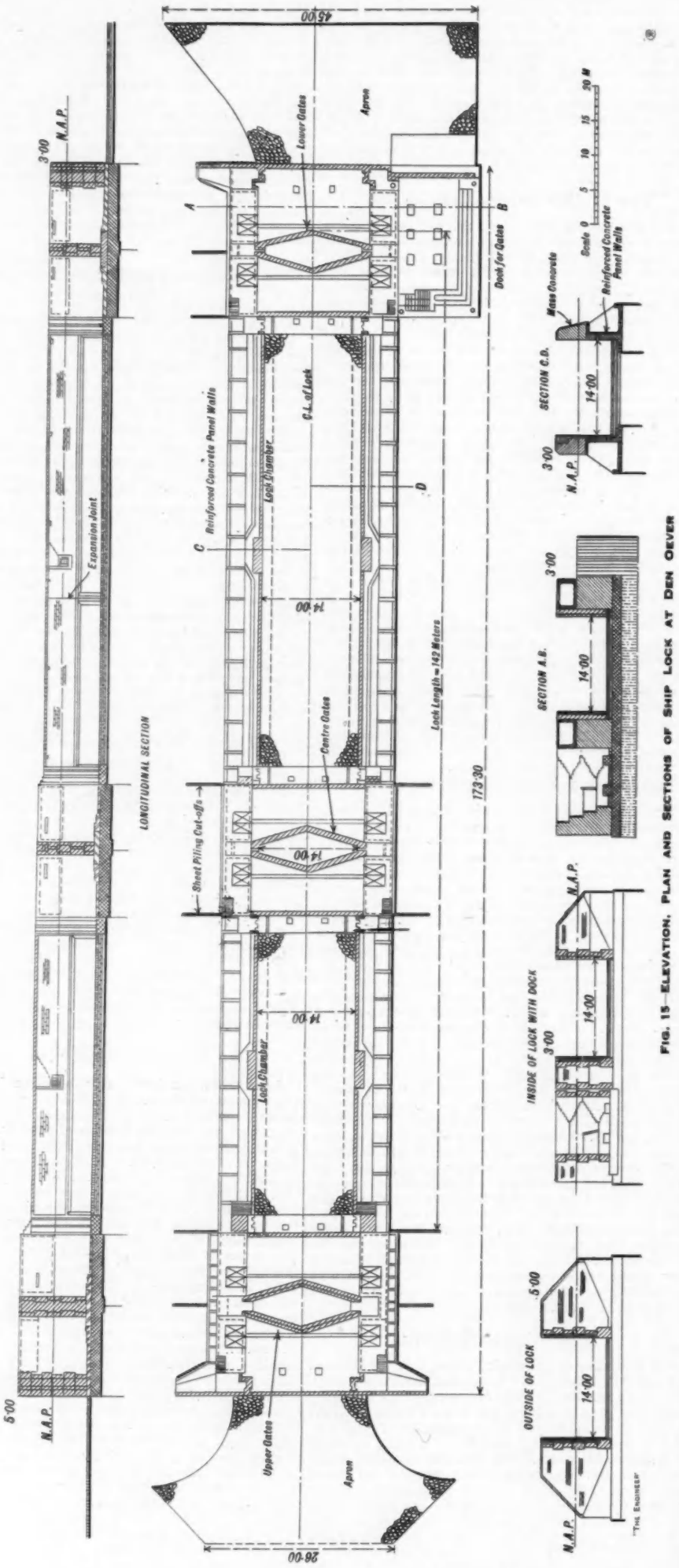


FIG. 15—ELEVATION, PLAN AND SECTIONS OF SHIP LOCK AT DEN OEVER

The Reclamation of the Zuyder Zee.

No. II. (*conclusion*).*

Locks.

THREE main locks are provided for in the dam. One, near Den Oever, suitable for vessels up to 2000 tons; one of the same size near the Frisian coast; and another at Den Oever with capacity for ships up to 600 tons. The lock at Den Oever is typical of the others, and will therefore be described. A plan, elevation and cross sections of it are shown in Fig. 15.

The width of the lock chamber is 14 m., and the depth over the sills below N.A.P. is 4·40 m. The length over all is 173·30 m. The lock is divided into two compartments by a centre set of gates, the length between the mitre points of the sills being 83·85 m. in the larger and 62·80 m. in the smaller compartment. There are six pairs of gates, three pairs pointing each way. This arrangement is necessary owing to the variations in the inner and outer water levels due to the tide.

The construction of this lock presents some interesting features. In the neighbourhood of the gates the walls and floor of the lock are constructed in mass concrete; but in the chambers, the lower part of the side walls is constructed in reinforced concrete panels with counterforts and bases, 6·40 m. wide. The two walls are independently constructed, the base being surrounded by sheet piling.

The upper part of the walls is in mass concrete resting on the upper flange of the reinforced concrete panel wall. The floor is constructed over the inside bottom flanges of the reinforced concrete bases of the side walls, as shown in cross section C–D, Fig. 15. The whole arrangement is designed to reduce the load upon the foundations to a minimum. Sheet piling cut-offs are provided at ten points behind the walls, as in the case of the sluices. A view of this lock is shown in Fig. 19, page 164, in which the reinforced concrete lower panel wall and its counterforts is clearly seen, as are also the mass concrete walls in the way of the gates. At the inner end of the lock a dry dock for the repair of the lock gates is provided. It is shown in cross section A–B—Fig. 15—and on the plan. Fig. 16 is a view looking along the lock from the Zuyder Zee end, and it shows on the left the dry dock for gates. The double granite hollow quoins for the pairs of gates back to back can be seen in the near gate recess. The gates are of steel, and are electrically operated.

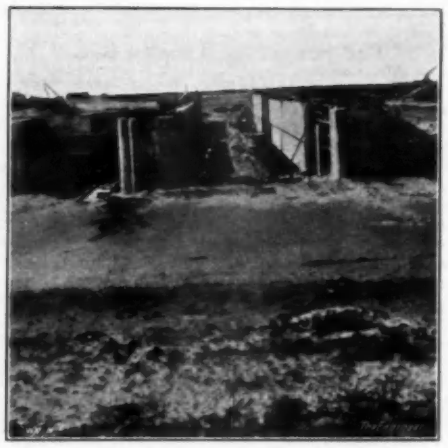


FIG. 16—SHIP LOCK AT DEN OEVER

The smaller lock at Den Oever, mentioned above, which is situated near the pumping station, is very similar in design to the foregoing, but has the following dimensions:—

Width	5·7 m.
Length inside gates	40 m.
Sill, canal side	2·80 m. N.A.P.
Sill, polder end	7·70 m. N.A.P.

Pumping Stations.

For the purpose of dewatering the new polders, when the surrounding embankments are completed, pumping stations are being provided at convenient places. At present, apart from the pumping plant at the experimental polder, two main stations are under construction, both for dewatering the North-West (Weiringen) Polder. One of them is situated at Den Oever—see Fig. 3 *ante*—and is to be provided with two horizontal-spindle centrifugal pumps, with a combined capacity of 500 cubic metres per minute, driven by six-cylinder heavy-oil engines; the other, which is situated at Medemblik, is at present in a more advanced stage of construction, and being the larger of the two and presenting several novel features in design, this station will next be described. It is built within an oblong enclosure, surrounded by temporary embankments, which has been pumped out and the subsoil drained in the manner previously described. With the exception of the foundations, the building,

* No. I. appeared August 9th.

suction and delivery culverts, &c., are entirely of reinforced concrete supported upon piles.

In the bottom of the North-West Polder a number of drainage canals are being dredged by bucket dredgers, which, when this work is completed, will pass out to sea through an opening purposely left in the bank near the Balgsand Canal. The opening will then be closed prior to pumping out the area. It will be seen from inspection of Fig. 3 that three of these canals radiate from the pumping station at Medemblik, and two from that at Den Oever. Figs. 17 and 21 show the pumping station at Medemblik, and the ends of the three radiating canals, leading into the suction pits, may be seen on the left of the plan. One of these channels with the entrance to the suction pit is shown in Fig. 20.

The general arrangement of the station is clearly shown in Fig. 17, from which it will be seen that there are three vertical-spindle centrifugal pumps driven by motors on the floor above. The motors are of the A.C. type, and each develops approximately 1000 brake horse-power. The capacity of the pumps is 450 cubic metres of water each per minute—say, 15,890 cubic feet per minute, or 2,860,200 cubic feet per hour for the three pumps running together.

The revolutions of the pumps vary from 88 to 120 per minute. The H.T. transmission line from the North Holland power stations is at 50,000 volts, carried upon wooden poles, the lower ends of which are inserted into reinforced concrete base plates, so that no part of the timber is buried. The current is stepped down and transformed to 3000 volts D.C. at the motors.

The volutes of these pumps are entirely of concrete, cast round a specially prepared collapsible mould, the only metal being a cast steel eye-ring, and the impeller itself, with shaft, &c. Similarly the intake chambers and delivery culverts are of reinforced concrete coated inside throughout with bitumastic paint. The experiment of making the pump casing of concrete is interesting, but no serious wear is anticipated, since the water will be free from sand. The pump impellers are 2·50 m. in diameter, and the intake chambers 5 m. by 1·50 m. at the outer end, tapering to a circular orifice 1·70 m. in diameter. The discharge of each pump is 1·90 m. by 1·70 m. next the pump, but the size of the culvert increases towards the outlet, and it is fitted with two penstocks in the course of its length. Fig. 22 shows the outer ends of the discharge culverts, with stone apron in front. Fig. 21 is a general view of this pumping station, in its present state, the intake culverts being on the left and discharge culverts on the right, above which may be seen the three sets of penstock gear.

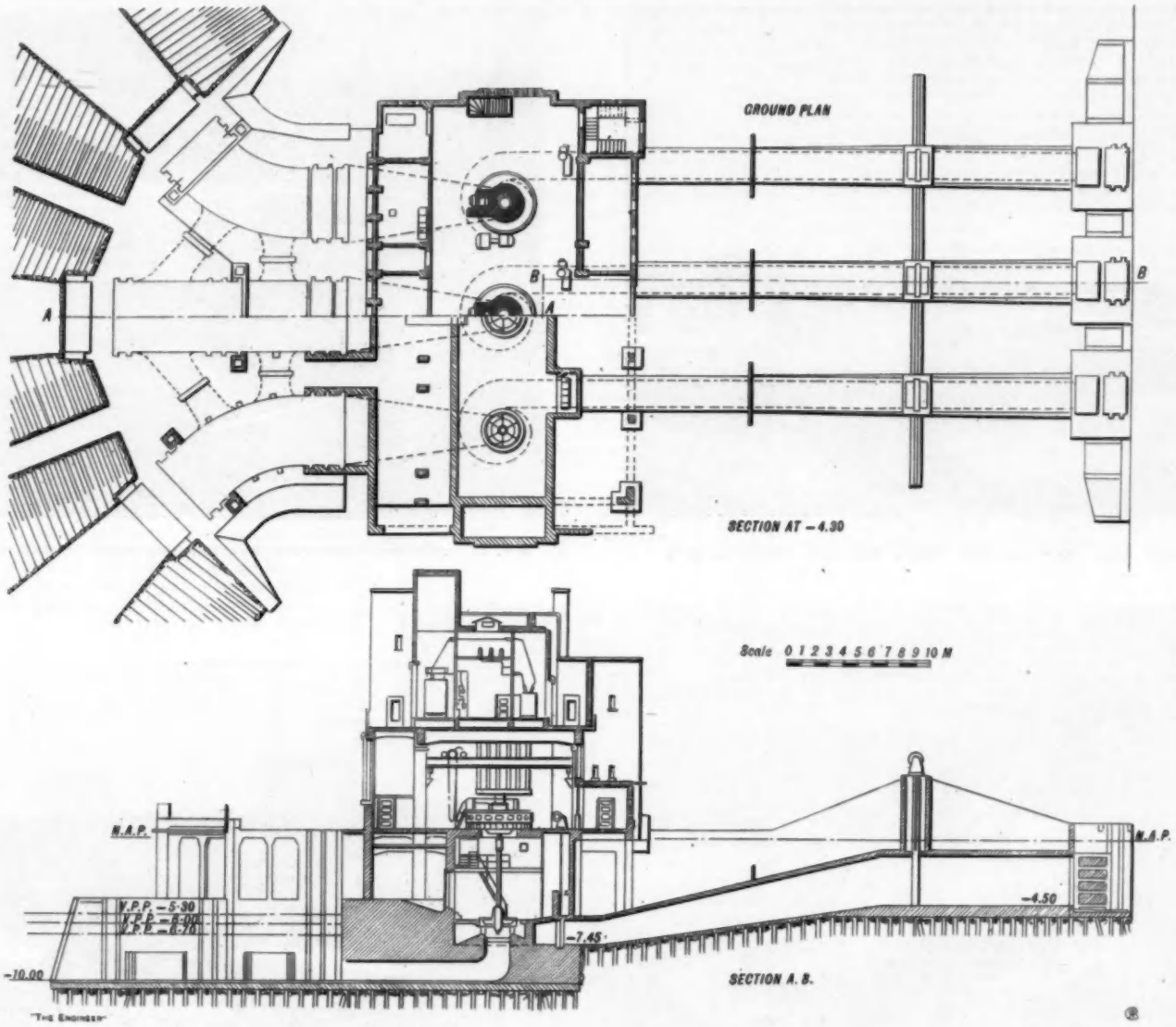


FIG. 17—PLAN AND SECTION THROUGH MEDEMBLIK PUMPING STATION

These pumping stations are designed to work against a maximum head of 6·95 m.; but in the earlier stages of dewatering the head will be much less, commencing from nil, and the duty given is the average estimated for the whole process of dewatering. After dewatering is completed, it seems probable that a different type of pump will be used for drainage purposes.

PLANT.

A very large quantity of plant, principally floating cranes, dredgers and barges, is being employed upon the works. Every available dredger, both bucket ladder and sand pump, in Holland is at work, and many have been obtained from other countries. Some idea of the quantity of floating plant at work may be gathered from the aeroplane photographs reproduced in Figs. 23 and 24, which show cranes, barges and reclamation pumps working upon a short length of the dam for the North-West Polder, which is just rising above the surface of the sea. Another engraving—Fig. 23—illustrates the construction of the first length of dam next to Medemblik, for the North-West Polder; and shows in the distance the enclosure for the pumping station, just described, laid dry; and in the foreground the dam in various stages, the portion next the pumping station being completed, whereas the part on the extreme right is in the early stage in which the boulder

FIG. 18—EXPERIMENTAL POLDER COMPLETED AND PUMPED OUT

RECLAMATION OF THE ZUYDER ZEE

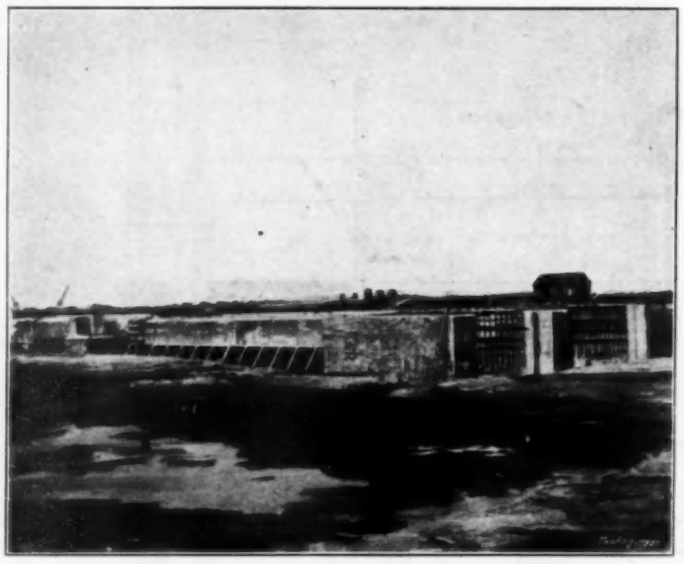


FIG. 19—SHIP LOCK AT DEN OEVER SHOWING COUNTERFORTS

FIG. 20—MEDEMBLIK PUMPING STATION—CONCRETE INTAKE CULVERT

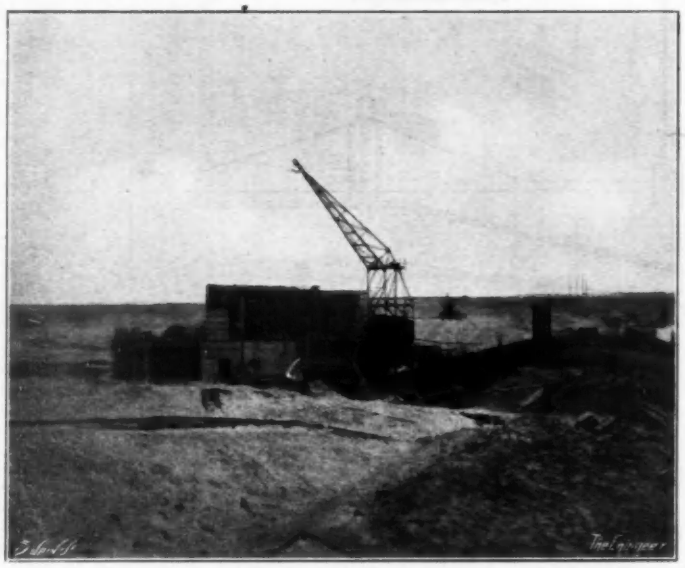


FIG. 21—MEDEMBLIK PUMPING STATION FOR NORTH-WEST POLDER

FIG. 22—MEDEMBLIK PUMPING STATION—ENDS OF DISCHARGE CULVERTS

FIG. 23—PART OF DYKE FOR NORTH-WEST POLDER

FIG. 24—FIRST PART OF DYKE FOR NORTH-WEST POLDER

UNIV. OF ILL.

clay bank is being tipped. One of the large floating grab cranes can be seen in the foreground.

EXPERIMENTAL POLDER.

Fig. 18 is reproduced from an aerial photograph of the completed experimental polder at Andijk. This view is included in order to show the only portion of the Zuyder Zee reclamation actually finished, and as an example on a small scale of the work generally. The original coast line, with the old dyke and the village and road behind it, can be seen on the right of the picture, the height of the old dykes being about 50ft. above the level of the land behind. On the left is the new dyke enclosing some 100 acres of the sea bottom, which is but little below the level of the adjoining land. A main drainage canal C has been dredged down the centre of the polder, with subsidiary canals C′ leading into it. At P is the pumping station with discharge pipes passing over the new dyke into the Zuyder Zee. When this polder was laid dry the remains of old dykes were found in the bottom, together with old timber piles, stonework, &c., that formed part of ancient sea defences which must have been breached and overwhelmed by the sea at some remote period, but of which no record exists. Rye and other crops are now being grown successfully in the polder, and experimental work, which will be of the greatest value when the larger areas are laid dry, is proceeding.

EFFECT OF THE WORKS ON TIDE LEVELS.

As had been anticipated, the effect of the shutting off, even partially, of such a large reservoir as the Zuyder Zee from the tide, has been to raise the level of high water outside the line of the main dam by an appreciable extent, and it is estimated that, when the dam is completed, the tide will rise at least 2ft. higher along the coast line inside the chain of islands than it did before the commencement of the works. This will involve additional expenditure on raising the older dykes along the coast.

COST OF THE SCHEME.

The estimated cost of the work authorised by the Act of 1925 is as follows :—

	£
Main dam from Weiringen to the Frisian coast	4,583,333
Locks and sluices	2,083,333
Incidental works	833,333
Approximately	£7,500,000

Dams and Pumping Plant for the Four Polders.

	£
N.W. Polder	3,083,333
S.W. Polder	8,416,666
S.E. Polder	11,916,666
N.E. Polder	7,000,000
	£30,416,666

Interest Charges at 5 per cent. for Periods until the Polders come under Cultivation.

	£
N.W. Polder	1,725,060
S.W. Polder	4,434,300
S.E. Polder	5,871,750
N.E. Polder	1,953,158
	£13,333,333

Total Gross Cost.

	£
Main dam, &c.	7,500,000
Dams, &c., for polders	30,416,666
Interest charges	13,333,333
Say	£51,250,000

As against this is to be set off the rents and sale value of land which becomes available from time to time during the progress of the work, which is estimated as follows, up to the date of final completion of the whole scheme :—

	£
From N.W. Polder	440,653
From S.W. Polder	1,973,200
From S.E. Polder	3,617,408
From N.E. Polder	1,953,158
	£7,916,666

The net estimated cost, therefore, excluding the work carried out prior to 1925 is about 44¼ millions ; but when the whole of the land is disposed of, it is estimated that the total sum realised will exceed 50 millions sterling, showing a considerable margin of profit.

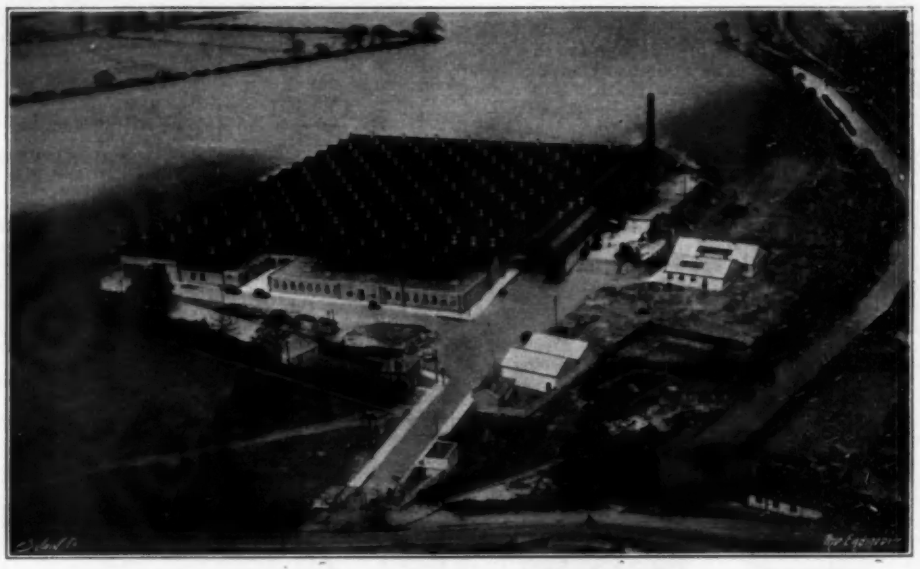
Whether this profit is realised or not, there is no doubt that the scheme is justified as a work of national importance, and the indirect profit not accruing immediately to the Government, but none the less increasing the prosperity of the country, will be very great.

No scheme of such magnitude has been carried out, or even proposed, in Europe hitherto, and its execution reflects great credit on the foresight and boldness of the Government of the Netherlands. There seems to be no doubt that that country will, in the efflux of time, reap a rich reward.

A SYSTEM of impregnating concrete piles with asphalt, for protection against sea water, which has been developed by the Los Angeles Harbour Department, is described in the *Engineering News-Record*. The piles are finished with a 1½in. coat of rather lean concrete and are impregnated by the vacuum-pressure process at a temperature of about 250 deg. Fah.

The Crown Gear Making Works.

THE Crown Works of the Moss Gear Company, Ltd., which have just been opened at Tyburn, Birmingham—that is, quite close to the British Industries Fair ground at Castle Bromwich—form the subject of this article. The Moss Works were, we believe, originally opened in Aston with the object of specialising in the production, on a large scale, of the transmission gearing required in the assembly of motor cars, and the company secured so much business of this kind that it could hardly be accommodated in the premises within the city. It was decided to move to a site where all the conveniences of a modern "layout" might be enjoyed ; but simultaneously there developed another consideration. And that was the violent fluctuations in the demands of the motor car building industry. It became obvious that, while the production of comparatively light-toothed gearing might be the mainstay of the business, it required some other branches to maintain an equable balance sheet. The result is that while the new works of this company, of which we give several illustrations, are palpably laid out primarily for the production of that class of gearing which is familiar to motor car engineers, quite a number of dissimilar articles are produced on an extensive scale without interfering with the "bread-and-butter" part of the regime. One instance alone will serve to emphasise this attitude. It is the manufacture of a number of rams for the compressing pumps used in a chemical factory, while the production of cam shafts for internal combustion engines is a commonplace in the works. The company is, also, now engaged in developing a wider range of gearings, such as double helical, both single and double reduction gear-boxes, worm reduction gears, concentric speed transformers, as well as a wide range of industrial gearing in general.



AERIAL VIEW OF THE CROWN GEAR MAKING WORKS

Originally the Moss Works occupied a four-storey building in Thomas-street, Aston, and although day and night shifts were worked, with as many as 900 machines in operation, the work overtook the capacity of the plant, and it was decided to make a move to the outskirts of Birmingham. This move has now been effected and the new works are in full swing. It is noteworthy that, during the whole of the transition stage, the productive capacity of the company was fully maintained, and we believe that this was attained to a large extent by the interchange of ideas between Mr. W. Duckett, the managing director of the Moss Company, and Sir Alfred Herbert, of Coventry. The transferences of these two businesses to new premises, of which we have already described one in our issue of September 7th, 1928, are quite comparable in character if not in magnitude. A series of views of the new works is given herewith and on page 172.

Two years ago a very fine crop of potatoes was gathered from the site where the new Moss Works now stand. Now there is, there, a single-storey building measuring considerably over 400ft. square and housing over a thousand machine tools, which give employment to 1100 operators.

Regarding the adoption of the single-storey system, we had some conversation with Mr. Duckett on the relative merits of single-storey and tall buildings, of which he has had experience in rather intensive conditions. The general impression which we gained from this conversation was that, while the transport of material in the process of manufacture was certainly facilitated by the single-storey arrangement, the principle had disadvantages over and above the amount of ground occupied. Thus, in winter time, it is sufficient to heat the lower part of a tall building to make the upper parts habitable, and the smaller roof catches less sun in the summer time. At Tyburn the long range of boilers devoted solely to the heating of the shops, and the smokestack, which looks nearly as important as that of a fair-sized power station, are sufficient evidence of the need for elaborate heating appliances. Nevertheless, we were told, the shops were uncomfortably cold during the cold spell of the early part of this year.

The heating boilers at these works are by Hopes Heating and Lighting Company, Ltd., and there are ten of them in a half basement at the north-eastern corner of the main building. They serve to supply, under the vacuum system, a range of 3in. steel pipes, which are arranged overhead throughout the main shop.

There are, obviously, three other sources of supply necessary for the conduct of the works—power, raw materials, and labour—and they may be taken in that order.

Power is provided exclusively by a tapping from the Birmingham municipal mains, and amounts to about 2000 horse-power. The current arrives at a pressure of 11,000 volts and is transformed down to 440 volts by means of six Foster transformers. A static condenser, by the British Insulated and Helsby Cable Company, is installed for correcting the load factor. In this connection we had some conversation with the man in charge of the electrical plant, and learned that he was greatly helped in the maintenance of a good factor by the large use in the works of electricity for furnace heating purposes ; but this matter will be considered later. There are also in this private sub-station two motor generators of 150 kVA each for providing direct current to those motors which must have a variable speed, such as those in the testing department and to magnetic chucks on the machines in the shops. There is, naturally, in this station a fairly extensive switchboard for distributing current throughout the works. It was supplied by the General Electric Company, Ltd. The principal feeders are carried along the various bays of the shops just below the eaves and branch out to the different consuming points overhead. The larger motors driving the shafting are also overhead, bolted on to the stanchions or the trusses of the roof, and are all of the alternating-current type. They drive the shafting through Hendry laminated belting, and we noticed that all the larger pulleys had the arms plated in to minimise windage. Some of the larger isolated machine tools have their own motors, of the direct-current type, and the lighting is taken off the alternating-current circuit. In this connection we noticed that a good scheme of colour painting has been adopted for all service mains, so that they may be easily traced out.

Apropos of painting, it was also noticeable that the general scheme of painting in the shops has been so carried out as to provide a harmonious contrast of colours, which certainly did relieve that impression of drab seriousness which one sometimes experiences in an engineering works devoted to mass production.

Taking next the provision of raw materials. In a business of this kind there are no really heavy units in the product, so no connection by direct siding with the adjacent railway has been considered necessary. All the materials, which consist principally of forged stuff, are brought in by motor lorries and are unloaded under the one bay of the shops, in which there is an overhead electric crane. It is of 5 tons capacity. Thence materials are moved to the places where they are required by auto-trucks running on the plain floor of the shops. Originally a system of rails was laid down throughout the various bays and aisles of the shop for the trucks, but the arrangement was not considered sufficiently flexible, and it has been found worth while

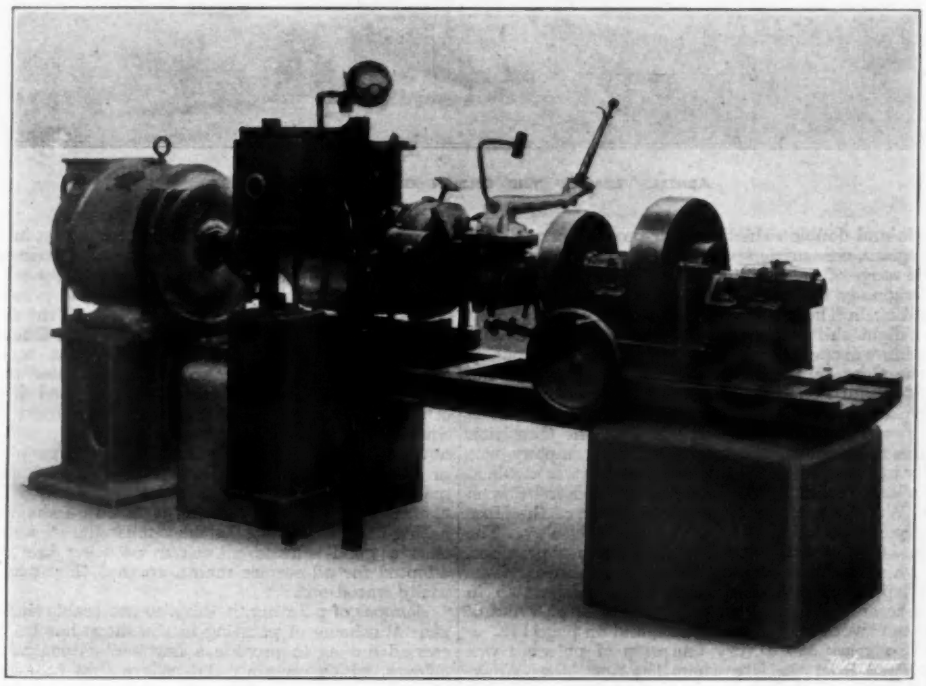
to fill in the clearance gauge of the rails so that trucks on rubber tires can run in any direction. It is hardly necessary to remark that raw material, in progressing from the works entry to the despatching department as a finished product, moves, as far as is possible, in a continuous route, and it appears to us that therein lies one of the chief merits of this modern single-floor arrangement of a factory.

As to labour, it is not quite so easy to explain the position of the works. There are, of course, plenty of men in the district fully competent to attend gear-making machinery, but it would seem that they generally prefer to work in the shops near the city and thus save travelling time. So the Moss Company has made good provision, in the way of garages, cycle sheds and omnibus services for these men, while there is a good canteen. We noticed, however, that there seemed to be a tendency towards the employment of hands, of both sexes, from the immediate vicinity for the manipulation of machines not requiring highly skilled attention. In this connection it was rather noteworthy that women—not girls—appeared to make good machinists, while girls—not women—were good at gauging and testing.

There is one other section of the business which might be dealt with on general lines, and that comprises the general administrative offices; but as the works were so new on the occasion of our visit that the new offices were not fully occupied, we will not enlarge upon them. The administrative work was still being carried on from the old works. There is, of course, a drawing-office of considerable extent, as the company does much work on general instructions besides that made to specification.

Here it seems appropriate to revert to the products of the factory, as a description of its equipment would be little more than a catalogue, while the machines installed, with few exceptions, are familiar to our readers. There are about a thousand of them all told, and our illustrations give a good idea of the style of the equipment.

As we have already said, the major part of the work turned out is gear wheels for motor car transmissions, and of them a great variety is made. It is noteworthy in this connection that quite small, and seemingly unnecessary variations are introduced by different designers, for gears which are intended for similar services, and the result is that different methods of cutting have to be adopted for each design. Thus hobbing may be suitable for one gear, while planing or shaping must be adopted for another. As a consequence, the Moss shops include practically every known make of gear-cutting machine. On them there are made all kinds of straight tooth wheels, helical and double helical gears, bevels and skew gearing, and worm gears. Among the last mentioned there is included "Guest's patented full encircling" type of gear, in which the worm has a varying diameter, with the smallest diameter at the middle of its length, so that full engagement is obtained with several teeth of its corresponding wheel. For producing these worms some special machines have been designed by the makers, and each worm is ground after it has been hardened. It will be understood that the mechanism of a grinding machine which has to follow the contour of these worms is very complex, and they are most fascinating machines to watch.

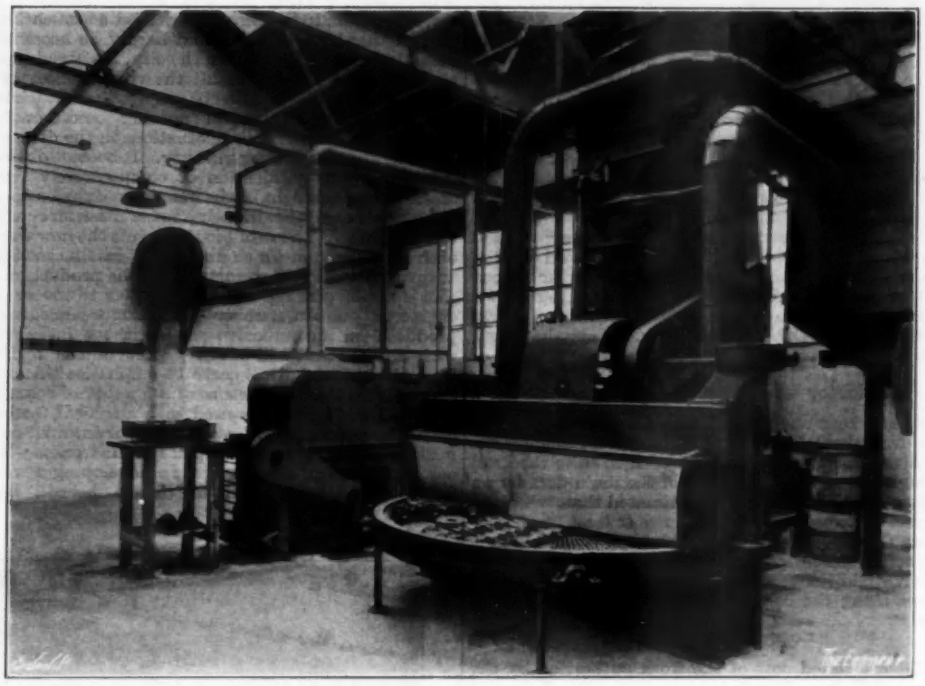


GEAR-BOX TESTING DEVICE

Many of the plain gear wheels made in the works are ground after they have been hardened, and for this purpose the company invariably uses the generating style of grinder; that is to say, one employing a plain flat abrasive wheel to follow the contour of the teeth.

At various stages in the process of making a gear wheel the piece is inspected and gauged, and for this purpose benches are established in a number of places throughout the shops, in contradistinction to the common practice of having one central inspecting department. The makers contend that in this way, not only is transport of material minimised, but also that the more intimate contact between the inspectors and the machine attendants helps the latter to maintain a high quality of product. There is, however, also a distinct testing department where complete gear-boxes are run under load. This department is equipped with a number of electric motors of about 20 horse-power, which can be varied in speed from 750 to 3500 revolutions per minute. The motors are installed in one room and their shafts protrude through close-fitting holes in the wall to another room, where the gear-box is erected. In this way the noise of the running motor is separated from that which may be made by the gearing, and a microphone instrument enables the tester to get a true impression of the condition of the gear.

There is a distinct department for the assembly of complete gear-boxes. In it we noticed that pneumatic tools are largely employed for such purposes as operating screw drivers, tightening up nuts, and so forth. The hardening shop is, naturally, completely walled off from the machine shop, and in it there are installed several furnaces of both the gas and electrically heated type. The gas-heated furnaces are by Gibbons and are 6ft. 6in. by 4ft. 6in. by 20in. high and are of orthodox design, while the electric furnaces, which are of approximately the same dimensions, are by Birmingham Electric Furnaces, Ltd. It is noteworthy, in this connection, that, despite the relative costs of energy, from a theoretical point of view, the electrically heated furnace is gaining in favour in these works. It was not possible, on the occasion of our visit, to obtain data for an exact comparison of the performance of the two types of furnace; but it was obvious that the electric units were the most favoured, and we were told that, after the preliminary heating, these furnaces consumed current at the cost of only 4d. per hour. The corresponding consumption of gas by the other furnaces may be gathered from the fact that they are fed by a 14in. main and that the gas pressure has to be "boosted up" by local compressors. It would appear, from our conversation with the men in charge of this department, that the electric furnaces have the added merit that their temperature can be controlled automatically within narrow limits, and we believe that this limit is about 3 deg. at hardening temperatures. There is also in this shop an automatic reheating furnace, in which the parts to be treated are arranged on a rotary table and are ejected at the proper time, or, if they are not ejected by the automatic mechanism, the whole machine stops, so that the pieces are not subjected to too prolonged treatment. There are also a Wild-Barfield reheating furnace and a Hump electric furnace.



AUTOMATIC SHOT BLASTING APPARATUS

REVOLVING RE-HEATING ELECTRIC FURNACE

There is one other striking impression which we have carried away from the works, and that revolves about the making of jigs for mass production work. In the toolroom there is a machine, of Swiss manufacture, devoted to the boring of holes in drilling jigs,

and its performance is an indication of the degree of accuracy required in the Moss Works. This accuracy was demonstrated to us by a specimen which had just been produced. Two slabs of iron about a foot square and, say, 1¼in. thick, had been drilled each with five holes. Four of the holes were equidistant at the corners of a square and the other was in the centre. The two slabs were drilled separately with the machine table set, on each occasion, at the extreme opposite range of its travel. By means of plug gauges, which were said, we believe, accurately, to have had no more than one-thousandth of an inch clearance, we tested the matching of these two slabs in every possible combination of positions, and in each case the gauge plugs dropped into position with perfect "sweetness."

The Sea.[1]

FROM the sea we have all come, and so has almost everything that we can touch or use; back to the sea all shall go: that is the summary of the address which I offer you to-day.

Sixty years ago, on July 20th, 1869, the Association met also at Dartmouth under the presidency of my grandfather, G. P. Bidder, C.E., and the address was on the subject of "Rivers." In tracing the origin of rivers to the surface or subterranean drainage of lands soaked by rain, and that of the rain to clouds, condensed from vapour drawn by the sun and air from earth and sea, the main source of these clouds and showers is described in a passage which I will quote in full:—

> "You know that three-fourths of the earth's surface is covered by water; and you know also that water, under ordinary atmospheric conditions, has a constant tendency to assume a gaseous form—in other words, to evaporate. If we spill a little water on a tray, we find that it will shortly disappear, and be absorbed into the atmosphere in the shape of aqueous vapour. This effect is, moreover, considerably accelerated by heat, or the motion of the air. But now suppose a similar effect to be in operation over a water area of 145,000,000 square miles, in many parts exposed to the burning rays of a tropical sun, and swept over and agitated by constant and violent winds, and you will perhaps be able to form some notion of the mass of water which is continually exhaling from the ocean in a gaseous form. I have attempted to make a calculation of this quantity, and I estimate that it may amount to about ten hundred thousand million (or a billion) tons per diem."

The estimate of your President in 1869 was made on the knowledge of the time in a round figure which properly professed no exactitude. During the sixty years which have elapsed, the investigations of Sir John Murray, Dr. H. R. Mill, and others, have slightly advanced the degree of our knowledge and show that the round figure may probably now be written a little more closely as nine hundred thousand million tons a day, instead of ten hundred thousand million tons.[2] That is to say, that there is daily evaporated from the surface of the seas an amount of water about equal to that in the English Channel from Dover and Calais to Portsmouth and Harve. From two-thirds to three-quarters of this will, of course, fall back in rain on the sea, but we know that from sea vapour and land vapour enough rain falls on the land in a year to cover it all to an average depth of nearly 3ft.—and on Dartmoor to cover the moor to two or three times that depth.

This evaporation and rain has been going on through all human history, and for untold epochs before. During the period of our monarchy since the Norman Conquest, the rain which has fallen on dry land has equalled the total volume of all the dry land—that is, of all land above sea level in the world. Human history is now extended to the beautiful jewellery and figured pottery of Ur of the Chaldees, which the excavators date from about 5000 B.C., and to the spirited animal paintings on the caves of the Rhone Valley, which they date at some 13,000 B.C., and earlier. During this epoch of human culture and human art, the amount of rain which has fallen on the land since 9000 B.C. has been equal in volume to the entire ocean.

The sun draws vapour also from the land, of which one-third will have contributed to this rainfall, but two-thirds will have fallen on the sea. Thus, apart from water buried in the deep rocks, all the water that is in the land and sea circulates continually. A few deep pockets in the ocean may be nearly stagnant, but on the average every drop of water in the ocean passes through the clouds once in 4500 years, and falls on to the land once in 16,000 years. There is a slight addition to the total stock when water streams out from lava in a volcanic eruption, but this in ten million years will not amount to ½ per cent. of the whole; there is a slight loss by the wandering away of hydrogen atoms from the upper surface of our atmosphere. Essentially, we have a definite limited stock of water which circulates on a course as defined and certain as the water in the Aquarium at Plymouth. In the vast clock of geological time this circulation is one of the rapid wheels; geologists tell us that it is 600 million years since the rocks of Start Point were solidified, and in that time, even at our present rate of evaporation, the whole ocean has fallen on the land in rain about 40,000 times.

It needs no elaboration to enable us to understand that the power has been enormous of this mighty deluge in changing both sea and land. Geographers have taught since Herodotus and Strabo that the rain washes mud and sand and stones down the rivers to spread them at the bottom of the seas, whence they will eventually arise again as land. We will not dwell to-day on this point of mechanical attrition of the continents by rain, but will consider more carefully the attrition by solution.

When a lady of Devon is exiled to the Eastern Counties, the first thing she notices is that her hands feel rough. Washing in Dartmoor water lubricates the hands as they rub one against the other; in the water of Brighton or Cambridge they grate. We all know that this is because the water from the chalk is hard; that is, it contains in solution carbonates and some sulphate of lime, a part of which can be thrown down, merely by boiling, as a white powder, or as a hard crust very detrimental to the domestic boiler and hot water pipes. We know also that the water is hard because it has washed this lime from the chalk, leaving fissures and sink-holes and underground water channels where the chalk has been dissolved away, and in the mountain limestone of the West Country eating out the wonderful winding caverns of the Cheddar Cliffs. Thus the lime from the dry land is being carried by every river into the sea—much by the chalk streams, little by the granite-born streams of Dartmoor. But that little, in the Devon streams, is a new addition to the lime available for use in the living world, for it comes from ancient volcanic rocks and has never been in the sea before it passes Dartmouth Castle or Drake Island. The lime which the chalk streams carry into the Thames, or the Somerset streams into the Bristol Channel, has all been in the sea before, for the chalk and limestone are ancient sea bottoms, and their lime was the skeleton of ancient sea creatures. So we have a circulation of the lime like the circulation of the water, only a thousand times more slow. It is true that in 50,000 years the rivers will bring down as much calcium carbonate as there is in the waters of the sea, but it took some 50 million years after the chalk was deposited before it was heaved up out of the sea to become dry land again.

We spoke just now of "the living world." The dry land, above the level of the sea, has under it similar rocks, often proved by deep mines far below sea level; and round every continent there is a shelf under shallow sea which stops rather abruptly at the 100 fathom line, and is known in many cases and guessed in other cases to be old land, now submerged. Thus, if the Channel Tunnel be made, it will be made in chalk or the underlying gault such as we see in cliffs near Dover and Boulogne. This submerged "old land" and the "deep land" of stratified depths underground, below sea level, amount in all to some three times the bulk of the "dry land," above sea level. We will consider them all as "land," and say that the "land" and the ocean and atmosphere together make the "living world," because every atom of it has been brought into the immediate surrounding of living creatures or—like the Dartmoor granite—is in the way to come into their immediate surroundings. On a 12in. globe the land and sea are about represented to scale by the coat of varnish. All the rest of the globe is inaccessible to living creatures, except for an occasional little mark in the varnish where there comes volcanic eruption. The eruptions are supposed to take place from a layer, which, to scale on our 12in. globe, would be about a tenth of an inch under the surface. Below this the papier mâché globe represents what we may call the "dead" Earth, which, so far as we know, will never come to the surface except in such a convulsion of the earth as might be supposed to annihilate all living creatures, such as could only be caused by some wandering star hurtling through our planetary system. Modern investigators say that below a sixth of an inch on our globe the real earth consists of heavier rocks than those in the crust, and that the core, more than half the diameter of the earth, is all of nickel-iron, with a fluid centre which in the 12in. globe would be the size of a cricket ball. Some have said that there is a central sphere of pure gold.[3] Whatever is there is out of our lives; we must be content with the gold and the iron and the lime that are in the living world—the thin coat of varnish representing rocks and water where life is or has been or will be spread over the great red-hot and white-hot sphere of unimaginable pressures and unthinkable atomic relations where life has never been and never will be.

It is in this varnish of land and sea, with the atmosphere above it, an eighth of an inch thick over our model globe,[4] that the water circulates, and it is in this same thin stratum that the lime of the living world circulates. Only about a seventieth of our stock of calcium is in the ocean, one-eighth is in the untouched igneous rocks of the land, like the mass of Dartmoor, and about seven-eighths of the calcium of the living world has been washed into the sea out of the igneous rocks, by rains which fell tens and hundreds of millions of years ago, and has been built into skeletons by corals and seaweeds and shell fish which lived and died, not only before man, but mostly before there was even a frog in the world. Their skeletons fell to the sinking bottom of the shallow seas and bedded in its mud, which thickened as the earth movements slowly lowered it for ten million years. Then some change in the balance of those movements heaved up the sea bottom in recent times to form the chalk of the Sussex Downs, or in far older times to form the limestone of the Somerset Mendips, on which the rain now falls and carries the dissolved lime away again to our English Channel to give material for shells of mussels and barnacles which, a hundred million years hence, will again be fossils in the cliffs and hills of dry land.

That is the circulation of lime—an element so essential to life that the heart cannot beat without it and the blood cannot clot without it. Our bones have in them the lime which served as skeletons for ammonites and belemnites of the chalk seas, and before that for beautiful lily stars of the mountain limestone, and before that for lantern shells of the Silurian, and before that for the unknown ancestors of the Pre-Cambrian. And long after the bones have served our turn, the lime in them will be busy in skeletons of creatures which we cannot imagine, who will form Devonshire Associations of incredible wisdom.

Water passes through the ocean and is used again and again thousands of times, lime passes through the ocean and is used again and again many times. "There is nothing new under the sun."

We said that almost everything that we can touch or use has come from the sea. What have the table and chairs and floor to do with the ocean?

Wood, as we know, is made by the tree from water and carbon dioxide—"carbonic acid gas"—under the action of sunlight. The water, we have seen, was in the ocean probably a few months, and possibly a few days before it came to the roots of the tree. What of the carbon dioxide?

Suppose that this flooring is of Norway pine, the air from which it was formed had blown over the Atlantic; all along its course gases were passing continuously from the air into the sea and from the sea into the air, maintaining a balance between them. So that a considerable proportion of the carbon atoms which are in this wood had been in the sea a few days or weeks before the wood was formed in the pine tree.

Our debt, however, to the ocean in this respect, though a debt for our very existence, is to the ocean not as a giver but as a taker of carbon dioxide; for carbon dioxide is a poison, and if the ocean did not take excess from the air life for us and our beasts would be impossible. The trees and plants in this country will make per acre every year about a ton of woody fibre, starch, and sugar, requiring the fixation of about 18,000 cubic feet of carbon dioxide. I make out that counting human beings, agricultural stock, domestic animals and wild creatures, there is in Great Britain an average of 2 cwt. of animal life per acre, breathing out twelve or thirteen thousand cubic feet of carbon dioxide in the year. Allowing that on one-tenth of Great Britain the vegetation is negligible—this includes roads and railways, towns, lakes and rocks—we have an average per acre of 16,000 cubic feet absorbed by the plants and 13,000 produced by the animals, which, with such rough figures, may even be really an exact balance. We cannot guess from this what would be the condition in a wild continent, where the food of the animals was eventually furnished by the vegetation of the continent. We draw our food from all continents and from the sea, and feed on the vegetation of at least four times our own area, so that it is possible that in a wild continent the animals produce only one-fourth of the carbon dioxide which the vegetation transforms. We know that over earth and sea they cannot produce more than half or two-thirds of what the plants use, because the oxygen which animals use is, one with another, nearly a third more in volume than the carbon dioxide which they breathe out, and it is stated that vegetation gives out nearly a third less oxygen than the carbon dioxide fixed.[5]

We may interpolate a word about oxygen. In the past history of the world the vegetation has provided oxygen, beyond what was used up by rusting metals, by breathing animals, and by forest fires, enough to accumulate the oxygen now in our atmosphere, which has all been formed from carbon dioxide by green plants in sunshine. Dr. Atkins' experiments at Plymouth indicate that an acre of sea in the Channel produces 5½ tons of seaweed—mostly floating and microscopic—per acre, which would give about a ton of dry weight,[6] about equal to the crop of an average hayfield on shore. If we take a ton an acre as a rough average all over the world, land and sea, tropics and arctics, the oxygen produced annually by this vegetation would be $^1/_{1500}$th of what there is in the atmosphere. Seeing that vegetation is supposed to have existed for 1500 or 2000 million years, this looks as if the balance of consumption and expenditure is very close, and possibly the oxygen in our atmosphere represents the stock accumulated by the action of vegetation before animals originated, and at the coal epochs, when vegetation was extraordinarily luxuriant. The known coal of the world[7] of Carboniferous and Permian ages only, excluding brown coal on the one hand or ancient graphites on the other, represents the fixation of more than twenty times the amount of carbon dioxide now in the atmosphere. It is moderate to assume that at least an equal area of coal, formed at the same time, has since been denuded or has not yet been discovered so that we must recognise the fixation of over forty times the present atmospheric carbon dioxide. This, effected by plants, involves the liberation of oxygen in quantity approaching one-fifteenth of the present oxygen of the atmosphere. Elsewhere[8] I have supported the view that there were three coal ages before the Cambrian, on which hypothesis the lignites, true coal, and the three ancient graphites might record the production of something of the order of five-fifteenths or one-third of the oxygen in our atmosphere; and the plants of these five coal epochs, of which the majority would not be fossilised, may have produced the whole quantity of our oxygen.

The present characteristics of animals and plants have been approximately maintained now for some millions of years, so that it is unlikely that their mutual reactions now appreciably either add to or diminish the atmospheric store. The oxygen of the air is continually passing into the sea, and *vice versâ*. We do not know whether land or sea is in debt to the other; but as the vegetation of the sea is all near the surface, and its animals distributed at various depths, it seems likely that the air gains oxygen over the sea from the minute surface flora, and gives it up to the animals on land. What is certain is that when air passing over the ocean is richly supplied with oxygen the sea receives more than it gives, and when air is poorly supplied with oxygen the sea gives more than it takes. It is to the great circulating reservoir of the sea that we owe the constancy in composition of the air. The continual supply of heat on the tropics acting on atmosphere and ocean forms the world's heart, that with annual pulse drives to us over the Atlantic a life-giving arterial stream of pure wind which takes away to the North Sea our blackened venous clouds of air laden with carbon dioxide. These are cleaned on the ocean, and made more fit to breathe again before they reach the Norwegian coast.

It is the absorption of carbon dioxide by the ocean which has made animal life possible on the earth. We have concluded that, even in Britain, plants absorb all the carbon dioxide exhaled by animals. But there are and

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[1] Presidential address delivered by G. P. Bidder, Sc.D., before the Devonshire Association for the Advancement of Science, Literature and Art, July 23rd, 1929.

[2] An easy general account of the relations of land, sea, earth and air is given in "The Realm of Nature" (London, third edition, 1924), by Hugh Robert Mill. The book is also a valuable compendium of fundamental numerical data.

[3] An account by Professor V. M. Goldschmidt of the latest conclusions as to the structure of the earth appeared in *Nature* for July 6th, 1929.

[4] This is about the height of the lower Aurora Borealis, with the air less than a millionth of the density of our air; but a still more attenuated atmosphere extends to several times this height.

[5] Sir F. W. Keeble, in "The Life of Plants" (1927), states that the annual world wheat crop, containing some 70 million tons of starches, sugars and fibre "handles" each year about 114 million tons of carbon dioxide and liberates to the atmosphere over 80 million tons of oxygen.

[6] "250 metric tons of carbohydrate are formed under each square kilometre"—W. R. G. Atkins, on page 78 of "Science of the Sea," an Elementary Handbook of Practical Oceanography for Travellers, Sailors, and Yachtsmen," Oxford, 1928.

[7] A. H. Gibson ("Natural Sources of Energy," Cambridge, 1913), estimates this at just under 12 billion tons.

[8] British Association Report (Leeds), 1927, p. 60.

always have been untold quantities vomited forth into the atmosphere by volcanoes, by hot volcanic caverns, and by hot springs. Had this remained in the air we could not have breathed it, but always any excess is absorbed by the great ocean, which contains about fifty times the quantity of carbon dioxide that there is in the air, so that a large percentage addition to that in the atmosphere makes a very small percentage addition to that in the ocean. Also in the ocean the carbon dioxide is not free, but is neutralised by the alkaline salts, so that the marine creatures take no harm from it.[9]

The sea receives through the rivers much carbon dioxide fixed from the air in the weathering of the igneous rocks, the carbonic acid and the silicates of the rocks forming carbonates and silicic acid; some of the silicates also pass down the rivers in suspension and are similarly decomposed in the sea. There an enormous amount of silicic acid is taken by the diatoms for their shells and by siliceous sponges for their spicules. Opal is the form of silicic acid which they use for their skeletons and the chalk is full of their fossils, though most of them have been dissolved by the water percolating through the chalk and the solution re-solidified as flint in any cavity of the chalk that happened to be empty. Every flint, therefore, represents the fixation of more than half its weight of carbon dioxide, most of which is reposing innocuously in the carbonate of lime of the minute fossil skeletons in the surrounding chalk. In the sea the carbonates are the same percentage as in average river water and there is less than a quarter the river percentage of silica, showing that silicic acid and carbonate of lime do not accumulate in the sea water but are greedily seized by sea animals and turned into hard solids, which eventually become rock again.[10]

It has been suggested also that marine animals which secrete ammonia act on the sulphate of lime—gypsum—in sea water by converting it in the presence of carbon dioxide into sulphate of ammonia, which they excrete, and carbonate of lime which builds up their skeletons. Our limestones represent, not only the accumulation of carbonate of lime from the rivers, turned into shells and skeletons, but also the fixation of free carbon dioxide from the volcanoes.

It is not only volcanoes which supply carbonic acid beyond what plants can utilise or animals endure. Here in Britain, where our animals already produce nearly all the carbon dioxide that our plants can fix, we burn some 200 million tons of coal annually. This puts out into the air an amount of carbon dioxide which would average 200,000 cubic feet per acre over all Great Britain, thirteen times what our vegetation can use, even if there were no animals, and fifteen times as much as we and our animals produce. If Britain's atmosphere were separated from the rest by a vertical wall from the cliffs up to heaven, so that we became really a self-contained country with our own share of air secured to us, the coal we burn would add in a year over 50 per cent. to the quantity of carbon dioxide in the atmosphere above our island, together with far worse poisons of which the natural atmosphere is practically innocent.

Fortunately for us, there is no such exclusively British atmosphere. Your south-wester sweeps across England in four hours and takes every trace of foul air away to the Arctic Ocean. We said that we feed on the vegetation of four times our own area, but we may be thankful that we breathe the atmosphere of forty times our own area. It is due to the ocean sending us fresh air and purifying our used air before it is returned to us that life on our manufacturing island in the twentieth century is possible. Those who doubt this should visit London or Manchester when an anticyclone has kept the weather windless for ten days in the winter—and remember that you must multiply that by 30 or so to get what our chimneys really do to the air in a year.

We see, therefore, that carbon dioxide is kept from annihilating us by the regulating action of the sea, its salts, and its living creatures. Let us consider what is the action of the ocean in regard to the beneficent element phosphorus.

There is plenty of phosphorus on the earth—an average of 2½ lb. per ton of rock—but there is commonly little in the surface soil and extremely little in the topmost fifty fathoms of the ocean. The amount of life on our planet is controlled and limited by the amount of accessible phosphorus. Every farmer knows that if he wants heavy crops he must add phosphates, and the phosphorus which he has bought he sends away in corn, and it is ultimately buried again as beef bones, which, unless ground, may take a thousand years before they are useful again, or as human bones, which are carefully guarded from agriculture.

Precisely similar conditions prevail in the sea.[11] One year's supply of phosphorus from the rivers, if evenly distributed, would give phosphorus in the sea only up to about eight parts in a billion, or 1 grain in 8000 tons. A grain of phosphorus may be enough for a fish of 2 oz. weight, and 8000 tons of water is a 22 yards cube, so that the new phosphorus added each year would only suffice for ten new 2 oz. fish per acre of 11 fathom water. If the fish remained alive, or were always eaten and completely digested by other fish, you would, of course, have 100 times this amount added every century and all the waters would by now be rich in life. But when the fish is eaten his bones are very often not digested, and they fall to the sea bottom and are buried in mud or sand which becomes in time a sandstone, so that their phosphorus is added to the rocks again as in the fossil fish bones which make the Devonian strata so interesting.

The fish cannot use much phosphate in solution in the water; he builds up his flesh by eating other fish or by eating shrimps which eat vegetables, and it is the vegetables that draw the dissolved phosphates from the water. Near the surface, where there is sunlight, little green spheres and threads, most of their number invisible to the naked eye, seize on all the phosphates in the water and only stop growing and multiplying when the supply is exhausted. The tiny shrimp-like creatures eat them, and the fish eat the shrimps and are eaten by other fish; but just as a farm is impoverished by sending away to the market bullocks and milk and hay, so the upper waters of the ocean are always being impoverished by bones and shells and other dead fragments of animals or plants falling by their weight into the dark depths of the ocean, and carrying their phosphates with them.

We come then to the curious paradox that the deep ocean where no sunlight can come, and therefore no plant can grow, is rich in phosphorus with no seaweed to utilise it; although, at the same time, in the bright sunlight above the ocean plants are starved for lack of any trace of phosphates in the water beyond that in the scanty crop itself.

What happens is dependent on that vital circulation of the whole ocean to which we referred in considering carbon dioxide and oxygen. We know now that on the movements of the ocean waters depends not only the respiration, but the nutrition of living things. Dr. Atkins has found at Plymouth that at the close of the winter the surface waters of the Channel contain the respectable amount of ½ grain of phosphorus to the ton. As, or when, the spring brings sunshine, the minute floating seaweeds begin to grow; as they grow the phosphorus in the water decreases. After a month or so of sunny weather there is a fine crop of minute weed and small animals feeding upon it—the whole is called "surface plankton"—but the supply of phosphorus is exhausted and the growth of the weed stops, in spite of the sunshine. However, there is still phosphorus in the water at the bottom of the channel, and, if a gale comes on heavy enough to stir the bottom water to the surface, this lower water phosphorus becomes available for the sun-lit surface, and the crop of plankton starts increasing again.[12]

The deep waters of the ocean hold between 1 and 2 grains of phosphorus to the ton, equal to 13,000 years' accumulation from the rivers. Where the ocean currents bring these bottom waters into shallow seas, their richness in phosphorus brings about a plentiful crop of seaweed and all the life depending upon it. This is especially the case in the Humboldt current, the cold current running northward from Cape Horn up the west coast of South America. We now know that this current is cold, not as used to be supposed, because it brings water from the Antarctic, but simply because it is flowing northward in the direction from the polar regions towards the equator. We know that, though they are full of antarctic fish and birds, the actual waters of the cold stream come from the deep Pacific.

The water in the northward current when it passes the opening of the Straits of Magellan is being whirled in the earth's rotation with an eastward velocity, like our own, of about 620 miles an hour. But when it gets up to Valdivia the circle on the earth's surface made by the parallel of latitude 40 deg. is a good bit larger than the circle made by the parallel of latitude 52 deg., and to get round it in twenty-four hours Valdivia has to move eastward at about 770 miles an hour. Therefore, if a magic carpet were suddenly to transport a bucket of water northward from the Straits to Valdivia, the bucket and the water would be left behind by Valdivia, and to someone lying, as he thought, motionless in a deck chair on the sea front, they would appear to shoot off actively to the west at 150 miles an hour.

Of course, the Humboldt current does not pass instantly from Magellan to Valdivia, but takes weeks over it, and on the average, whenever the water moves 5 miles northward, the land hurries away a mile to the east of it, so that for the whole 50 deg. of longitude through which the Humboldt current flows there is a steady off-shore current. When there is an off-shore current, we know that it can only be a surface current, because if below it there were not an equal compensating shoreward current, the bottom would become bare. So that all along the west coast of Chile there is a strong northward Humboldt current and a surface drift outward, going perhaps a quarter of a knot to the northerly knot and a-half, and a shoreward bottom current replacing continuously the surface water, as it drifts away, by bottom water dragged up from the deep Pacific.

This bottom water is, of course, icy cold, and it is full of phosphates. In richness perhaps five or six times the largest percentage that we get in the Channel. Consequently, the water swarms with all grades of life, and because it is cold and continuous with the southern cold surface water, the animals are antarctic species; so much so that penguins have been found in this current right up to the equator and a few miles north, and most antarctic species of birds can be seen in and over the stream.

When an American zoologist,[13] just returned, gave a most interesting account of these waters at the Oxford meeting of the British Association, Dr. E. J. Allen, of the Devonshire Association, pointed out how beneficial the Humboldt current is to the English farmer. The current brings up the deep waters of the Pacific, laden with phosphates, consequently the vegetable plankton grows in the semi-tropical sun luxuriantly and plentifully. Consequently, there is an enormous amount of small crustaceans living on the plankton weeds, and swarms of small fish who find easy eating in the clouds of crustaceans, and shoals of larger fish who devour the small ones whole. And, above, crowding white wings whirl and swoop, as innumerable sea birds mark their fish and dive for it unerringly. How many fish a gull can eat I do not know, but our visitor described all the rocky islands as white with their droppings, insomuch that a company is working the islands systematically for guano. So their unsavoury cargo rounds Cape Horn eastward, crosses the line in the Atlantic, and enables the Devon farmer to replace the loss from his land, caused by a heavy crop of potatoes or wheat, with phosphates from a mile and a-half deep in the Pacific Ocean. And these he is only able to buy because a degree of longitude in latitude 40 deg. is 10 miles longer than a degree in latitude 52.

The farmer also uses the phosphorus of deposits from old seas of moderate depth, such as the so-called "coprolites" near Cambridge—phosphatic nodules, which occasionally occur in various strata in sufficient quantities to be useful. We require phosphorus, for our brains as well as for our bones: cheap phosphate means cheap food, and it is tantalising to think of the rich stores inert in the deep inaccessible sea.

It seems almost time to allude to the fact that the sea contains salt; meaning thereby *par excellence* sodium chloride, the salt of our dinner-table.

Sodium chloride differs from all the other solubles of the sea already considered, inasmuch as at first sight it seems to have no circulation, but to pass continuously from the land to the sea and to be accumulated there. There is very little "common" salt in river water; about a quarter of a grain of sodium chloride in the gallon of average river water, as against the 190 grains to the gallon of sea water. It was suggested by Halley, the astronomer of comet fame, that by computing the volume which the rivers pour annually into the sea and the volume of the whole sea it was possible to calculate how many years the sea has taken to accumulate its salt. The great Dublin chemist, Joly, reinvented this ingenious idea, and made the calculation with much care and knowledge. He gives the authoritative opinion that, when the primeval ocean first formed on the cooling crust of the earth, it could only dissolve from the rocks one-ninth of the chlorides which it now contains. He estimates the sodium passing down the rivers and came—in 1899—to the conclusion that the age of the ocean was 80 to 100 million years.

There are many objections to this conclusion, apart from the strong evidence in recent years, from radio-active changes in minerals, that the ocean is some twenty times this age. Sodium in a sample of river water can be measured accurately, but to know the sodium brought down in the course of a year, even by one river in one year, would require very numerous measurements, not only of percentage of sodium, but of the volume of the river. Holme objects that the quantity estimated by Joly is more than the worn-away rocks contain, and, further, that there is no evidence at all of a corresponding amount of chlorine being taken into the sea sufficient to convert the other sodium salts into sodium chloride. He recalculates from another angle the quantity of sodium carried down, and brings out the age of the ocean as 330 million years if the erosion has always been at the same rate; but he argues strongly that the land is now exceptionally mountainous, and therefore the rate of erosion is exceptionally high—an interesting and unfamiliar suggestion.[14]

Leaving this difficult question, we may, however, note that there is a real circulation of salt, which not only goes into the sea but returns from it. The various salt mines, whether of Cheshire or New York, are of sea salt from old seas. Modern geologists are perpetually stating that this and that formation was laid down in a shallow sea, or, definitely, in a land-locked sea. We know of such seas in our time; we know the Caspian, the Sea of Aral, and the Dead Sea. Each was once in connection with the ocean, but they have been separated from it and are in regions where the evaporation is now greater than the water received from rivers. Consequently each sea is surrounded with salt plains. The water which was cut off from the ocean is distilled into the air, falls in rain and returns to the ocean—it is very difficult for the ocean to lose permanently any water, though it may lend it. But in distillation all the salt remains behind, so that when a portion of the ocean is cut off as an inland sea without outlet, all the salt which was in that piece of sea is rendered back to the land. The salt of the sea water in the interstices of sandstone is also returned to the land when the bottom of the sea is elevated, and there is salt returned in the spray of a gale which blights the trees 40 miles inland and can be tasted on the lips 100 miles from the shore.

It is obvious that this circulation of salt back from the sea to the land, to be washed down again, puts a great difficulty in the way of accurate calculation of chronology. There can, however, be little doubt that the restitution of salt to the land has not kept pace with the passing of salt out of the land, and this is shown by the fact that the sea has now 4½ times the quantity of sodium that there is in the dry land, so that even if we multiply the latter by four to allow for the submerged and buried land, the sea still holds 10 per cent. more sodium than does the whole "land."

The American geologist, Joseph Barrell, looked at the salt of the sea from another point of view, taking the percentage in igneous rocks and calculating what quantity of igneous rocks must have been worn down, first to last, to produce the amount of sodium in the sea and in the sedimentary rocks. He arrived at the conclusion that the rocks so worn down must have amounted in all to 3·3 times the present volume of dry land.[15] That seems an extremely interesting result; we see that it approximates to an estimate of the total volume of sedimentary rocks above and below sea level. It, of course, does not include the uneroded igneous rocks of the dry land, nor the igneous rocks which are similarly enlaced with the stratified rocks in the submerged land. If we allow that they are equal in volume to one-seventh of the volume of the stratified rocks we find the "land" to be 3·8 times the volume of the "dry land." In our discussion we have used the round number 4 instead of 3·8, but our justification for this being more than a guess must rest in the saltness of the sea and the comparison made by the late Professor Barrell with the percentage of sodium in igneous and stratified rocks.

We have not time to study the interesting question of nitrates, with their relations on the one hand to the life of plants which consume them, and on the other to the lives of

[9] The carbonates and bicarbonates in sea water combine with carbon dioxide and so enable the absorption of 100 times the volume of carbon dioxide which distilled water would receive under similar conditions. See H. W. Harvey (1928), "Biological Chemistry and Physics of Sea Water" (Cambridge), p. 64 and f. Also J. R. Bruce (1924), *Brit. Journ. Exp. Biology*, ii., p. 63.

[10] At the high volcanic temperatures silicic acid is more powerful than carbonic acid, so that eruptions pour forth in the lava molten silicates of soda, potash and lime, accompanied by large quantities of free carbon dioxide. At our temperatures carbonic acid is more powerful than silicic acid, so that sedimentary geology has re-sorted the elements into carbonates of soda, potash and lime, accompanied by silicon dioxide, which may unite with water to form silicic acid, or may crystallise as quartz. Thus the glassy lavas of the igneous rocks, as they are weathered down, give place to limestone and chert in the old formations and later to chalk and flints.

[11] On phosphates, nitrates, arsenates, &c., in the sea, consult index of Harvey's book. References will be found there to the papers by Atkins.

[12] For a readable description of the natural history of plankton and other marine organisms, with excellent pictures, see "The Seas: Our Knowledge of Life in the Sea, and how it is Gained," by F. S. Russell and C. M. Yonge (London, 1928).

[13] Dr. Cushman Murphy.

[14] The criticism will be found in chapter iv of "The Age of the Earth, an Introduction to Geological Ideas," by Arthur Holmes (1927; Benn's sixpenny library), a book which should be read by anyone interested in this address. Another valuable criticism is in "The Earth," by Harold Jeffreys (1924, Cambridge; but a new edition is published this summer). Joly's paper is summarised in Geikie's Geology, book ii, part 1 (p. 78 of 1903 edition). See also Bidder, Address to Section D., Brit. Ass., 1927, Appendix A.

[15] Quoted in Schuchert's "Textbook of Geology," pp. 54 and 133 (New York, 1924).

the bacteria which build them up and of the bacteria which break them down. Nor can we do more than name the strange relations of certain bacteria to iron salts, which are said to have been extremely important in certain phases of the sea. Iron is used by plants in their green chlorophyll and by animals in the red hæmoglobin of their blood, but many marine animals use a salt of copper for respiratory purposes instead of hæmoglobin, and copper now appears to be not a negligible element in living tissue. Arsenic is an important element in relation to life, not merely as a means of ending it. It appears probable that in scarcity of phosphorus, arsenic may sometimes to some extent take its place.[16] Many sea animals contain appreciable quantities of arsenic; I have been told that a lobster contains a larger quantity of arsenic than is allowed to be sold under the Food and Drugs Act.[17]

It is difficult to point to any element in the sea which is unimportant to us, for the salts of our blood are nearly, if not quite, all the salts of the sea, in nearly the same proportions, but at about one-third of the strength. But there is one whose supreme importance binds us to live within reach of the sea or where the sea has been, under the gravest penalties. For some years now we have known that the goitre among adults and cretinism among children are due to deficiency of iodine. There is no danger in Devon, swept by spray, of those punishments which fall on the inhabitants of the Derbyshire heights in the centre of England or of the Swiss heights in the centre of Western Europe. But the discovery has brought out in a dramatic manner our dependence on the sea, so that even now we cannot remove ourselves from it entirely.

We have not touched on the great part that the sea has played in human civilisation as the great road uniting all countries, and particularly uniting Dartmouth with every other country, from Hudson's Bay and the Spanish Main to India and China. This aspect of the sea is more striking than ever now, when we know that, more than 3000 years before Drake, the Blue Stones of Stonehenge were brought round by sea from Wales to Hampshire, and when the doctrine is growing in strength that earlier still, men and women had sailed round the Indian Ocean and crossed the Pacific in their primitive canoes. Our neighbours the Cornish were bold with their skin coracles long, long ago. I like to believe that they had for their tin two strongholds, known before history as the Cassiterides. One was St. Michael's Mount in Britain, where they accumulated the tin until the fleet crossed, and one was Mont St. Michel in Brittany, where it awaited safely the departure of a caravan along the great trade route to Marseilles or Narbonne.[18] They carried their tin ingots across the Channel in their open boats of wicker and skins, 170 miles as the pigeon flies, and no man can guess how much further in a skimming dish with one square sail. They made that voyage in those boats as their regular business.

This, however, is not my regular business. You have done me the honour to elect me your President as a biologist. And as a biologist I have endeavoured to show how our life depends on the ocean, how we owe it to the sea that we have air that we can breathe, how the lime in our bones has been in the sea and will go back to it, how the phosphorus in our brains has been in the sea and will go back to it, how our life has been evolved to fit itself to the conditions imposed on us by the sea and by the steady streams of wind formed over it and which could only be formed over it. We take our rain from the sea, whether on the cornfield, or trickling over the ground to form our drinking water. We take our oxygen, our iodine, our water power, the shapes of our landscape, the datum of our surveys. We owe to the sea our existence, as a nation, our courage and our endurance; we owe our glory, our pride, our wealth, our daughter countries round the globe, our safety from our neighbour countries. The living creatures of the land are offspring of the sea and depend on the sea, but man in particular; and of all men especially Englishmen; and of all Englishmen Devon men.

[16] J. Comère (1909), quoted by W. R. G. Atkins and Miss E. G. Wilson (1927); *Journ.* Mar. Biol. Assoc., XIV., p. 612.

[17] Dr. Orton, of the Marine Biological Laboratory, is quoted by Atkins and Wilson as stating that oysters contain more arsenic than is allowed to be sold in foodstuffs.

[18] Identification of St. Michael's Mount with the Ictis of Poseidonius is made by Kenrick, Oman and others, though opposed by Elton. I regret that I have failed to trace the author of the suggestion as to Mont St. Michel. Oman says that the Britons sold their tin at St. Michael's Mount to merchants who carried it to Gaul. As to the Cassiterides, if a tidal island was used as a magazine, might not the prehistoric merchant who bought there have naturally supposed that the island produced tin? The ancient geographer would be informed by the ship captain, returning from St. Michael's Mount, that he was sold the tin by the inhabitants of an island far out to the north in the ocean beyond Spain; the caravan trader from Mont St. Michel would tell that he struck off to the north-west from Narbonne, and after many days' journey reached a tin island near to the coast. The geographer would intelligently combine the information and state that tin was found in two islands off the north-west corner of Spain, one near the coast and one further out in the ocean.

The Fuel-Injection Process in the Air-Injection Oil Engine.*

By J. S. BROWN, Ph.D.

THE characteristic feature of the indicator diagram from the air-injection oil engine is the constant pressure period during the injection and combustion of the fuel, this pressure being only a small amount in excess of the compression pressure. That is to say, the compression is carried to the pressure required to ensure satisfactory self-ignition of the fuel on its injection, but this ignition causes little rise in pressure, as there is only a restricted quantity of fuel then present in the combustion space. Following this, the injection proceeds in such a manner that the continued combustion maintains a constant pressure during the earlier part of the working stroke. This constant pressure feature is a valuable factor in restricting the maximum working pressures, which are here limited to the neighbourhood of the compression pressure, so that this pressure then forms the basis of design of the cylinder parts, and indeed of the whole engine structure. In contrast to this, the mechanical injection engine appears to require combustion conditions which involve the acceptance of a considerable rise in pressure beyond the compression pressure, giving an indicator diagram with a definite combustion peak, which may represent 350 lb. per square inch * pressure rise. Some measure of equality in the maximum pressures between the two cases has been obtained by reducing the compression pressure in the case of the mechanical injection engine, but this has then led to instances where the compression temperature is insufficient to ensure self-ignition of the fuel, and involves the further consequence of preliminary heating of the jackets before such mechanical injection engines are got under way.†

There is no occasion to discuss the qualities of the two

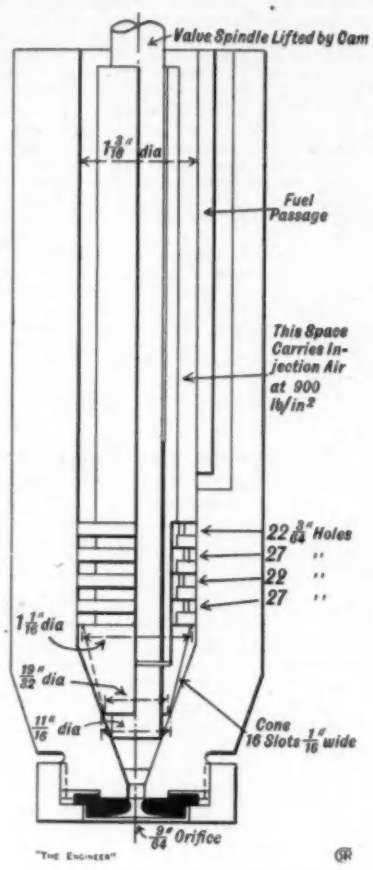


FIG 1—NORMAL PULVERISER

injection systems in their fuel distribution throughout the combustion space, although these may enter as a factor in the final portion of the combustion processes; but it is evident that in the initial phases of combustion there is a definite contrast which calls for detailed examination.

In the case of the air-injection engine the fuel is fed into the cylinder through a device named the "pulveriser" located within the body of the fuel valve, and it is known that the tuning up of new engines is largely a matter of using trial and error methods to find the most satisfactory proportions for this unit. In what follows a new method of experiment is developed to trace the actions within the pulveriser, leading to the conception of two separate phases in the air-injection process, and showing that the characteristics of different pulverisers can be explained on a basis of the simple features in their design.

The engine on which the tests were conducted may shortly be described as of Mirrlees manufacture, with one cylinder 12in. bore by 18½in. stroke, and operating on the four-stroke cycle at 200 r.p.m. The governor acts on the fuel pump suction valve, and so varies the effective portion of the pump delivery stroke. This suction valve is also actuated by a separate hand control, intended to come into use when stopping the engine. All the records which appear were taken at about the rated full load of 35 B.H.P.; and the fuel in use was generally a boiler quality oil of 1200 secs. Redwood viscosity at 100 deg. Fah., the investigation having been formulated during a study of the use of such fuel oils.

It is necessary to establish a clear conception of the process by which the fuel is fed from the fuel pump to the pulveriser. The pump is actuated by the engine and each delivery stroke supplies the quantity of fuel required for one working cycle; this quantity alters with the load carried by the engine, and is varied by a control on the effective portion of the pump delivery stroke, here the governor control on the pump suction valve. The relationship between the angular setting of the excentric operating the fuel pump and the position of the engine crank, in its working cycle, is such that the pump delivery is made to the pulveriser at a time when the fuel valve is shut; this feature is well recognised and accounts for the appearance of a gang of separate pump drives on multi-cylinder engines, where otherwise the whole group might be actuated from one crosshead. The passages within the fuel valve body lead the fuel to a position immediately above the pulveriser, while the whole of the internal space within the fuel valve body is kept charged with the blast air at about 900 lb. per square inch. The pulveriser construction varies somewhat in different engines, but the general form may be described as a series of galleries interconnected by a number of small holes. In the present engine the normal pulveriser is shown in detail in Fig. 1. It has four rings each drilled with holes of 3/64in. diameter superimposed on a slotted cone. During the course of the tests this pulveriser was modified to a series of more elementary forms. There is a very short time interval between the delivery of the fuel to the fuel valve body and the opening of the fuel valve by the cam, say, one-tenth second, and it would follow, from the small size of the holes in the pulveriser, that each injection charge can be taken to lie on the top gallery of the pulveriser. The viscosity of the oil would permit only a slow percolation to the lower levels, and this could only occur with a counter-current release of the air, which already occupies these lower levels. The delivery of the oil to the fuel valve can therefore be visualised as forming a solid collar of oil on the top gallery of the pulveriser, the depth of the oil increasing with the progress of the pump delivery stroke, and the top surface of the oil driving back the blast air towards the upper part of the fuel valve body. This collar of oil is then the initial position of the fuel injection charge. It is to be noticed that this oil charge has isolated a quantity of blast air in the lower levels of the pulveriser, and this air will have prior access to the cylinder on the opening of the fuel valve.

The process of injection is controlled, in respect of both its instant of commencement and its angular duration, by a cam on the engine lay shaft. The injection commences at some small angle, say, 7 deg., in advance of the crank reaching the end of the compression stroke, and the total duration of opening is about 40 deg. The height to which the valve is lifted by the cam is much in excess of the quantity [(diameter of valve seat)/4] which gives full flow area, so that the lift does not exercise any prominent influence on the flow during the main period of the injection. On the valve commencing to open, the blast air above the collar of fuel on the top gallery will proceed to drive that fuel through the pulveriser, the blast pressure being much in excess of the pressure in the cylinder. Some portion of fuel will be held up at each of the lower galleries, and will be progressively entrained in the air stream in an atomised condition to give the prompt combustion which is necessary on entering the cylinder. It is the detailed actions on this charge of oil which are here under examination.

The only item of equipment which entered into the tests was the indicator, here a Maihak instrument. It was used with a piston area of ¼ square inch and with a pressure spring of 280 lb. per square inch per inch height of diagram. In the earlier stages of the tests the normal indicator drum was replaced by a continuous recording drum, also a Maihak unit, but the refinement of the continuous drum was found to be unnecessary, and it will be shown that all the data can be gathered with a normal indicator.

The feature of the investigation lay in operating the engine at full power and taking a continuous indicator record over the period where the hand control on the fuel pump was used either:—(1) To cut out or (2) to cut in the fuel deliveries, care being taken to avoid the delivery of a fractional charge of fuel. With the continuous drum in use the two processes follow in sequence, but with the ordinary indicator each record requires to be taken separately. Further, in the case of the continuous record, it is necessary to notice that the fact that the paper itself travels around the drum during the return stroke of the indicator cord explains why a compression-re-expansion cycle, where there is no combustion, does not give superimposed lines. These compression-re-expansion cycles will appear when no fuel is being injected, but the continuous drum shows the lines as enclosing a small area. This merely demonstrates that the continuous record is unsuitable for planimetering, a position well established from previous experience. Thus the author has analysed such a record from a marine engine in the process of reversing,‡ but there the fuel valves were inoperative and the record is of no service in the present connection.

Typical diagrams are reproduced in Fig. 2, which includes tests with both Diesel grade fuel oil and the viscous

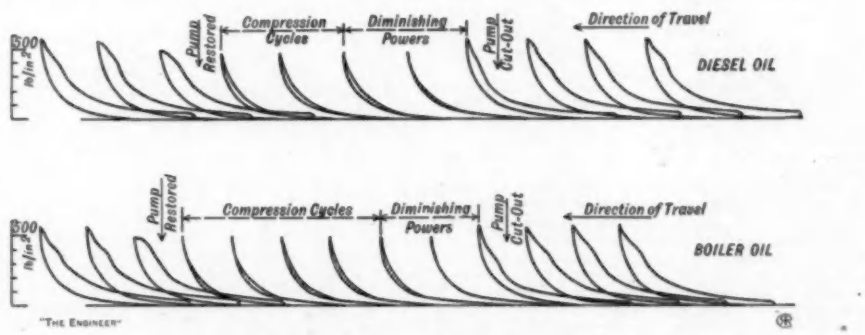


FIG. 2—TYPICAL INDICATOR DIAGRAMS

* Reprinted from the *Journal* of the Royal Technical College, Glasgow, January, 1929. Abridged.

* This figure is from the oil engine at Robert Gordon's Colleges, Aberdeen; makers, National Gas Engine Company.

† *e.g.*, in the Doxford and Scott-Still engines.

‡ "Trans.," Inst. Engn. and Shipbds. in Scotland, Vol. LXVI., 1922–23, p. 336.

boiler quality fuel oil. In the case of these continuous records, the order in which the engine cycles are recorded proceeds from right to left. The centre portions show a number of compression-re-expansion cycles, which here include a narrow area, for the reasons already given, while at both ends there is a series of normal power cycles which extend indefinitely on the records from which the figure has been prepared. Tracing the changes which occur on passing from the power diagrams to the compression-re-expansion diagrams, that is on cutting out the fuel pump, it will be seen that there are two cycles showing features of an intermediate character. As no fuel was reaching the fuel valve during this period it would follow that the final normal injection did not leave the pulveriser free from fuel, this carry-over of fuel then providing the two next following injections. This shows that the injection system does not work on any close principle of individual measurement of the fuel charges. On the contrary, each normal injection must consist of part of the fuel delivered by the pump on the preceding cycle, together with an advance portion only of the pump delivery intended for the cycle in question. The residual portion of the latter delivery has then to be visualised as carried over on the pulveriser to the next following cycle. Should this view require further confirmation it is immediately provided by the abnormal features present in the later diagram showing the first cycle following on the fuel deliveries being restored, or "cut-in." Here the initial conditions of the pulveriser show it to have been definitely free from fuel, and the entry of the first full charge has given a diagram with a prominent deficiency in the combustion pressure, corresponding to a delayed injection, as would here arise from the absence of a primary charge on the lower galleries of the pulveriser. As this injection charge has to travel from the top gallery, the results show that the normal injection charge does not wholly do so. Taking these two records together they fully substantiate a hypothesis that during normal working the pulveriser always carries some quantity of fuel; and it follows by inference that the normal injection consists in part of fuel delivered by the pump during the preceding working cycle of the engine.

The continuous diagram having been used to establish the typical form of these records, it became possible to revert to the use of the normal indicator, with its advantage that the variations in the power cycles could then be planimetered. As the record had to show the changes during the successive cycles, which the normal indicator would record in a superimposed manner on the card, it became essential to take separate records of the two processes of :—(1) Cutting-out; and (2) cutting-in. These modified records are reproduced in Fig. 3, and may now be compared

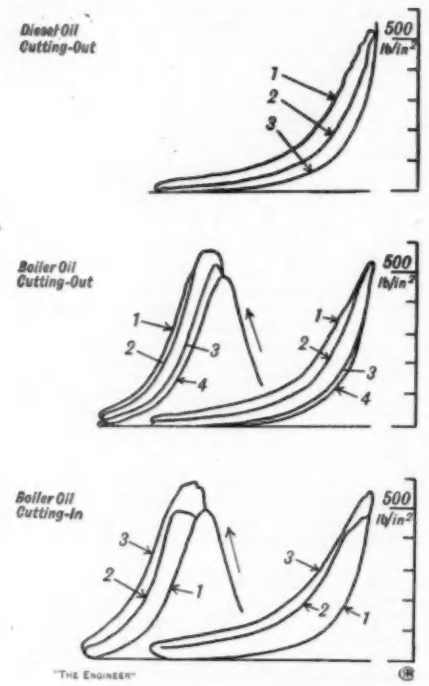


FIG. 3

with the continuous diagrams. Thus the top diagram shows the normal power cycle on Diesel oil together with two cycles after the pump has been cut-out. This record now affords a very clear demonstration of the effects under discussion, the first carry-over cycle, line 2, showing an area of about 40 per cent. of the normal card, while the early part of combustion is very similar in both. The second carry-over cycle, line 3, here shows pure re-expansion, so that the pulveriser did not retain the fuel beyond the first cycle; in this respect the card differs slightly from the corresponding continuous diagram with Diesel fuel, where a small power output was given. The second diagram is from a similar test using boiler oil, and is supplemented by a record of the combustion lines as given by a displaced diagram operated from the cam shaft. Here the card area on the first carry-over cycle, line 2, is considerably increased, and is followed by a second power cycle of lesser area, line 3, pure re-expansion only being reached in the third cycle, at line 4. The displaced diagram permits a detailed study of the combustion processes in the successive cycles; and, as the early part of the combustion in the first carry-over cycle closely coincides with the normal power diagram, it follows that the injection processes must commence similarly in the two cases. This point will be considered later. The bottom diagram was obtained by a reversal of the procedure followed in the above cases, and now illustrates the actions during "cutting-in," as distinct from "cutting-out." It progresses from pure re-expansion in line 1, to a card with late ignition in line 2, and then to the normal power cycle in line 3. The late ignition in line 2 is particularly well shown in the displaced diagram. Both grades of fuel oil, Diesel and boiler qualities, show substantially similar characteristics, and further references will be made to boiler oil alone.

These records evidently provide distinctly interesting information relating to the injection and subsequent combustion of the fuel charge. A considerable part of their value lies in the direct comparison obtainable between the normal and the carry-over cycles, and for this purpose the diagram given by the standard indicator is preferable to that from the continuous recorder.

The analysis of these diagrams has already brought out that the pulveriser always carries some quantity of fuel during the normal working of the engine, and that this condition leads to the injection charge passing into the cylinder as fractions from two or even more successive delivery strokes of the fuel pump. It now becomes necessary to recast a series of factors which influence the operation and the control of the air-injection oil engine. These may be taken in the following order :—

(1) Detailed theory of the actions during injection.
(2) Experimental evidence that this theory explains various changes in pulveriser design.
(3) The influence of the angle-of-advance, and of the angular duration-of-opening of the fuel valve.
(4) The use of carry-over diagrams on the engine test-bed.
(5) The cases of fuel valves used in horizontal and in inverted positions.
(6) The effects on the governing of constant-speed engines.

These points are dealt with in detail in what follows.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE VENTILATION OF THE PROJECTED CHANNEL TUNNEL.

SIR,—Investigations concerning the air resistance on trains in tunnels, which I have made in 1928–29 at the Albis and Bötzberg Tunnel of the Swiss Federal Railways, the results of which will shortly be published,* enabled me to study the influence of passing trains on the ventilation of these tunnels.

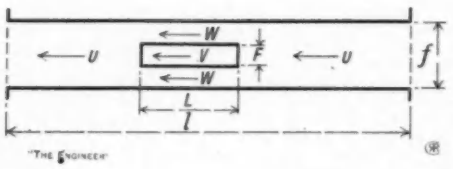
Based on theoretical deductions, into the particulars of which I do not enter, the following formula may be established for the velocity of air in the case of trains passing through tunnels :—

$$a \cdot v^2 - b \cdot (V - v)^2 \pm c \cdot w^2 - h = i \cdot \frac{d\,v}{d\,t} \quad . \quad . \quad (1)$$

in which

V = speed of train in m./sec.,
v = velocity of air behind and in front of the train in m./sec.,
w = velocity of air along the train in m./sec.

These velocities are positive if they have the same direction as the passing train.



$\frac{d\,v}{d\,t}$ = acceleration of air in the tunnel in m./sec.²

and the coefficients a, b, c, h, i may be calculated by means of the following equations :—

$$a = \frac{\gamma}{2\,g}\left\{\frac{\lambda}{4} \cdot \frac{1}{r}(l - L)\right\} + \frac{\gamma}{2\,g}\left\{\xi_h - \xi_v\right\} \quad . \quad . \quad (2)$$

$$b = \frac{\gamma}{2\,g}\left\{\frac{\Lambda}{4} \cdot \frac{1}{R_Z} \cdot L\right\} \frac{f^2}{(f - F)^2} + \frac{\gamma}{2\,g}\left\{\frac{1}{\psi_v^2} - \frac{1}{\psi_h^2}\right\} \quad . \quad . \quad (3)$$

$$c = \frac{\gamma}{2\,g} \cdot \frac{\lambda}{4} \cdot \frac{1}{R_T} \cdot L \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

h = difference of atmospheric pressure between the two tunnel faces in kg./m.²,

i = mass of air in tunnel per m.² of cross section $= \frac{l \cdot \gamma}{g}$ . . . . . (5)

in which

γ = specific weight of air in kg./m.³,
g = constant of gravitation in m./sec.²,
l = length of tunnel in m.,
L = length of train in m.,
f = cross section of tunnel in m.²,
F = cross section of train in m.²,
u = perimeter of tunnel in m.,
U = perimeter of train in m.,

r = hydraulic radius $\frac{f}{u}$ in m.,

R_Z = hydraulic radius $\frac{f - F}{U}$ in m.,

R_T = hydraulic radius $\frac{f - F}{u}$ in m.,

λ = coefficient of adherence for air on masonry,
Λ = coefficient of adherence for air on the surface of trains,
ξ_h = coefficient corresponding to the loss of pressure at the entrance of air into tunnel,
ξ_v = *id.*, corresponding to the gain of pressure at discharge,
ψ_v = coefficient of contraction at the head of the train,
ψ_h = coefficient of contraction at the end of the train.

In the case of the investigations mentioned above, which referred only to uniform movement of air in the tunnel, *i.e.*, $\frac{d\,v}{d\,t} = 0$, and to no natural ventilation, *i.e.*, $h = 0$, equation (1) may be written as follows :—

$$a \cdot v^2 - b \cdot (V - v)^2 \pm c \cdot w^2 = 0 \quad . \quad . \quad . \quad (6)$$

But as under such conditions the term $c\,w^2$ is practically equal to zero, equation (6) may be reduced to

$$a\,v^2 - b\,(V - v)^2 = 0 \quad . \quad . \quad . \quad . \quad (7)$$

whence

$$v = \frac{-b + \sqrt{a \cdot b}}{a - b} \cdot V \quad . \quad . \quad . \quad (8)$$

is inferred.

Under such simplifying assumptions the orginally unknown coefficients γ, Λ, &c., were determined as follows :

$\lambda = 0{\cdot}027$
$\Lambda = 0{\cdot}058$
$\xi_h = 2{\cdot}16$
$\xi_v = 0{\cdot}77$
$\psi_v = 0{\cdot}66$
$\psi_h = 0{\cdot}95$

It is of special interest to apply these results to the ventilation of the projected tunnel below the Channel.

For the project, published by Mr. Sartiaux in the *Bulletin* of the International Road Congress, 1910, and the traffic assumed therein, the integration of equation (1), which is carried out graphically, gives the following average velocity of air in the tunnel :—

TABLE I.

Cross section of tunnel in m.².	Average velocity of the air in the tunnel in m./sec.	Av'rage quantity of air induced into one tunnel tube in m.³/sec.	Average time needed to renew once the air in the tunnel in min.
14·1	6·79	95·7	113
16·6	5·12	85·0	150
19·1	4·21	80·4	182
21·6*	3·67	79·4	209
24·1	3·28	79·0	234
26·6	2·96	78·7	259
29·1	2·74	79·7	280
31·6	2·65	83·7	289
34·1	2·60	88·6	295
36·6	2·57	94·1	299

* Profile proposed by Mr. Sartiaux.

From Table I. may be seen that the passing trains ventilate the tunnel quite sufficiently, and even in the case of most disadvantageous atmospheric conditions, which is proved in the publication referred to, no artificial ventilation will be needed.

Thus the completion of the artificial ventilation plant which will be used during the period of construction is, in opposition to the report of Mr. Sartiaux, not at all necessary to obtain a sufficient ventilation during service.

KARL SUTTER, R.R. Eng.,
Assistant, Professor of Highway Eng., Swiss Technical High School, Zürich.

* "Der Luftwiderstand auf Eisenbahnzüge in Tunneln. Versuchsergebnisse vom Albis- und Bötzbergtunnel der Schweizerischen Bundesbahnen."

MECHANISED FARMING.

IT is announced that the Royal Agricultural Society of England proposes to hold a series of World Agricultural Tractor Trials during the summer and autumn of 1930. The trials, which are to be carried through in conjunction with the Institute of Agricultural Engineering, Oxford University, will be on a scale not hitherto attempted in this country, so as to provide a demonstration of the value of the application of power-driven machinery to cultivation.

The trials, which are to be held near Oxford, will be divided into two parts :—(*a*) Tests of a scientific and practical nature, which will be conducted in private; and (*b*) public demonstrations, to be held during September, 1930, when machines from all parts of the world will be seen in operation under strict working conditions.

Machines may be entered for the trials, without any restriction as to their country of origin, weight or horse-power, and for the purpose of the scientific tests they will be divided into four separate classes :—

(1) Direct haulage tractors, capable of field operations, road haulage, &c.;
(2) Cable sets with ploughing or cultivating implements;
(3) Self-propelled ploughing or cultivating machinery, not necessarily suitable for general haulage; and
(4) Special machines not included in the above classes, but which are self-propelled and capable of field operations.

Entries must be received not later than December 31st, 1929. The necessary forms and full particulars of the trials may be obtained from the secretary, Royal Agricultural Society of England, 16, Bedford-square, London, W.C 1.

Railway and Road Matters.

The directors of the Great Western Railway have promoted Mr. J. F. Lean to be principal assistant to the general manager, Mr. James Milne, who, before he succeeded Sir Felix Pole, ranked as assistant general manager.

The utility of the Kennett and Avon Canal of the Great Western Railway is again being questioned, and it has been suggested that it be converted into a motor road from Reading to Bristol. The Great Western, we would answer, would welcome that or any other scheme that would relieve it of the responsibility for maintaining the canal, but the trouble lies with the farming, gardening and other interests who rely on the canal for water supplies.

In *The Times* of August 9th was a letter on the subject of the closing, as from October 1st, during the rush hours, of two of the stations between Baker-street and Finchley-road on the Metropolitan Railway. The pertinent suggestion therein made was that some of the trains should run into the Marylebone Station of the London and North-Eastern. We would, however, point out that although that is quite feasible, as there are suitable junctions north and south of Harrow, the majority of the passengers, being for the City, would have to find their way along the Marylebone-road to Baker-street.

The net earnings of the Canadian Pacific Railway for June—2,992,925 dollars—were the highest shown for any month of June for twelve years. They showed an increase of 115,740 dollars, as compared with June, 1928. The gross earnings, amounting to 18,322,596 dollars, attained the highest level in the history of the company. For the six months period, the gross profits, which were 101,464,751 dollars, show an increase of 3,940,948 dollars. This is the first time that the gross profits for the six months' period has passed the 100,000,000 dollars mark. The net earnings for the six months showed a decline of 94,906 dollars.

The amount of railway passenger duty payable by the Great Western Railway was roughly £30,000 a year, which, it was agreed with the Government, represented a capital sum of £700,000. The directors, in return for the cancellation of the duty, have agreed to spend £900,000 on five schemes. They include a large concentration yard at Acton, further modernisation of equipment at South Wales docks, the completion of the substitution of electric light for gas in all corridor stock and in all non-corridor coaches that have first-class compartments, and the replacement of 100 further locomotives of obsolete types with modern engines.

The Great Western Railway was the pioneer in this country of the "Safety First" movement, out of which there have been many developments on that and other British railways. A commendable step towards accident prevention is the creation of "teams" of a score or so of men in varying grades, each of which men is given a risk value according to his occupation. The value was assessed at between 3000 and 4000 per team, and the average has been one accident to every value of 12,000. Last year there were twenty-three accidents among a risk value of 545,237, so that at 12,000 per team there was a surplus of 269,237 marks, or a reduction of nearly 50 per cent. in the average.

The official statement for the month of June, issued by the Canadian National Railways, indicates a continuance of the activity in transportation which prevailed during the earlier months of the year. Gross earnings for the month amounted to 22,196,108 dollars, as compared with 22,032,767 dollars for the corresponding month of last year, an increase of 164,154 dollars. Working expenses amounted to 19,755,993 dollars, leaving net earnings of 2,440,927 dollars, as compared with 19,226,108 dollars, and net earnings of 2,806,658 dollars in June, 1928. For the first six months of the year gross earnings were 127,145,211 dollars, working expenses 106,256,265 dollars, and net earnings 20,888,945 dollars, as compared with gross earnings 123,213,526 dollars, working expenses 103,343,150 dollars, and net earnings 19,870,375 dollars, for the corresponding six months of 1928.

During the month of June last the Southern Railway ran 86,930 steam-worked trains, of which 70·64 per cent. arrived at their destination on time, and 22·11 per cent. were not more than 5 minutes late. The average time the 29·36 per cent. were late was only 1·26 minute. During the corresponding month of 1928 the proportion on time was 63·14 per cent. and the average late arrival of the remaining 36·86 per cent. was 1·86 minute. There were in June last 83,707 electrically operated trains, of which 77·67 per cent. were on time, and the average lateness of the remaining 22·33 per cent. was 0·56 minute. There were also 15,429 freight trains, and 88·7 per cent. of these arrived on time. Of the freight trains an equally commendable feature was that the average late departure was only 1·6 minute. The average number of wagons per train was 32, and the trains travelled at 9·55 freight train miles per freight train hour.

On page 497 of The Engineer of April 30th, 1926, it was stated that by the "Prevention of Accidents (Extension of Time) Rules, 1926," made by the Ministry of Transport, the owners of wagons, possessing between 3000 and under 20,000 wagons, were given another five years in which to complete the provision of either side brakes to these wagons. That postponed the time limit until November 7th, 1931, which also was the limit given to the owners of over 20,000 wagons. By an Order made on April 25th, 1929—Statutory Rules and Orders, 1929, No. 351—another five years, *i.e.*, until November 7th, 1936, was given to those owning fifty such wagons or over, subject to the following conditions:—(*a*) To make a return each year for the next seven years as to the number of unfitted, partly-fitted and fitted wagons owned by him on December 31st; (*b*) to satisfy the Minister, from time to time as required, that the total number of unfitted and partly-fitted wagons is not unreasonable; (*c*) to satisfy the Minister, when the information is sought after December 31st, 1931, that the number of unfitted and partly-fitted wagons does not exceed the number laid down in the schedule attached to the present Rules. That schedule provides for the Great Western 10,000 unfitted and partly-fitted wagons; London and North-Eastern, 11,500; London, Midland and Scottish, 50,000; Southern, 7000; and each private owner 10 per cent. of his total stock.

Notes and Memoranda.

According to Mr. H. G. Moulton, of the Institute of Economics at Washington, the St. Lawrence waterway project is unsound economically. He says that the cost will be much greater than the estimated £200,000,000; that the projected channel is too shallow, and costly harbour facilities have not been taken into account; that the existing routes are shorter to all save a few North European ports; that neither outbound nor inbound cargoes exist in important quantities; and that hydro-electric power development would be premature by many years, as industries do not exist at points where this power could be marketed to advantage.

A silver-lead discovery which is described as the most important in Australia since that at Mount Isa has, says the *Financial Times*, been made at Mountain Range, South Goulburn, in New South Wales, near the Captain's Flat Mine, which is now being developed by an English company. A syndicate has acquired the lease covering the deposits and proposes to form a company to be called Anglo-Austral Investments. The mine is called Mount Galena. Lodes have been traced from the base to the top of the mountain 1000ft. long and 500ft. wide. Assays taken from the caps of various lodes have, it is reported, returned up to 46 per cent. of lead and 8 oz. of silver to the ton.

We learn from *Nature* that the Foucault pendulum for demonstrating the rotation of the earth is to be re-suspended in the Science Museum. For many years Foucault's notable experiment was to be seen in the old galleries now occupied by the Imperial War Museum, and it always created great interest. In its new position it will, our contemporary remarks, be seen by many who have never previously heard of it. Foucault, we are reminded, described his pendulum to the Paris Academy of Sciences in February, 1851, but he had already erected one in the Paris Observatory. It was some years afterwards to be seen on the Champ de Mars. Foucault's second method of demonstrating the rotation of the earth, by means of the gyroscope, was described in 1852. It is from that our modern gyroscopic compasses and other similar instruments come.

The aeronautical correspondent of *The Times* remarks concerning the Junkers engine that it appears to have reached such a remarkably low weight for this type that, with a little further mechanical development, it should have a definite advantage for all long-distance aircraft, particularly large flying-boats, which may need to travel long distances between bases. The successful application of the two-stroke principle is presumably the secret of the weight, when dry and without airscrew hub, of 3 lb. per H.P., and it is understood that Junkers engineers are satisfied now that they can produce an engine for general use with a rated power of 600 H.P. at 1500–1600 r.p.m. which will pass a 100-hour standard type test. Commercially, the comparative weights of a petrol and heavy-oil engine are not the only factor, for the much lower cost of crude oil than of petrol must be taken into consideration.

A paper read before the Optical Society recently by Dr. J. S. Anderson describes an ingenious form of shutter for aerial cameras, in which the exposure is made by means of what might be described as a Venetian blind. Concerning the shutter, the doctor says that the results obtained with it showed that as long as the leaves are suitably proportioned the variations in the durations of exposure and in the efficiencies at different points of the photographic plate are very small. As is to be expected, the efficiency of the shutter is much lower than that of a focal-plane shutter working with a wide slit. On the other hand, this type of shutter possesses one distinct advantage over the focal-plane shutter, namely, that the ratio of the total time during which light falls on the plate or any part of it to the duration of exposure at any point is very much smaller, so that there is less likelihood of distortion in the image.

The jointing ring on the manhole of an old Galloway boiler flew out and was consequently the subject of inquiry by the Board of Trade. In connection therewith the inspector makes the following remarks:—"As there were no circulating valves fitted, it was the usual practice to fill the boiler well up and to run the cold water out of the bottom when steam was showing in order to insure a uniform temperature, but, according to the evidence, that was not done on this occasion, and it would appear that neglect of it was the cause of the explosion. The attendant stated that he screwed the door up periodically, but as the bottom of the boiler would be cold, that would not have the same effect in bedding the jointing material as when done in a warm condition, and it is probable that when circulation did start in the boiler as the pressure rose, and the jointing material was softened by the heat, the nuts were not sufficiently tight to hold the joint between the door and its landing."

The disposal of the brines produced with crude petroleum and natural gas has long been a source of trouble to oil and gas operators, as well as to farmers and stock raisers in the vicinity of producing fields. Several hundred barrels of such brines may be produced daily from some wells. Vegetation is killed when oilfield brines are allowed to flow for a considerable time over the surface of the ground. The contamination of fresh water streams by oilfield brines affects not only human and live-stock water requirements, but also is destructive to fresh-water fish life. Methods suggested for the disposal of oilfield water are storage in evaporation ponds; evaporation of the brines for the recovery of commercially valuable dissolved constituents; diversion into surface streams; and return of the brines to suitable sub-surface formations. This latter method, however, is not generally used. There is always the danger of subsequent contamination, even in isolated areas; also the sub-surface formation, which may be used as a reservoir, is not always of sufficient thickness and porosity to take the brine at the required rate and at comparatively low pressures. If this method is used, great care must be taken that the brines are delivered to a reservoir formation from which migration cannot take place with detrimental effect to sources of fresh water supply and to developed or potential oil and gas-bearing strata either adjacent to or at a considerable distance from the reservoir.

Miscellanea.

On Saturday last, August 10th, Mr. Ernest Latimer, director of the Manchester Ship Canal Company, and formerly managing director of the undertaking, died in Manchester. Mr. Latimer had been on the staff of the company since 1888, and was accountant for two years before becoming general superintendent. In 1916 he was appointed managing director. Mr. Latimer, who was an Irishman, went to Manchester as a boy.

To protect all vessels using the Woosung Harbour from danger of grounding, further dredging of the Woosung River will shortly be started by the Special Municipal Government of Shanghai in accordance with instructions from the Kiangsu Provincial Government. The estimated cost of the undertaking will be approximately 800,000 dollars, which will be jointly provided by the Shanghai Special Municipality and the Kiangsu Provincial Government.

The Harbour Engineer-in-Chief to the Madras Government has presented to the Port Trust Board estimates for two alternative harbour schemes at Tuticorin. The first estimate relates to the construction of a complete harbour at Hare Island, and the second relates to an alternative harbour scheme at Tuticorin. The Hare Island Harbour scheme is estimated to cost 120 lakhs of rupees, and the harbour at Tuticorin is estimated to cost 152½ lakhs.

The widespread outcry against the use of foreign stone for the construction of roads in this country is apparently having a beneficial effect. According to a statement issued by the National Federation of Granite and Roadstone Quarry Owners, the imports of broken foreign roadstone for the half year to the end of June was 113,062 tons, as compared with 164,920 tons during the same period of 1928. In June alone only 21,743 tons entered the country, as compared with 38,313 tons the year before.

A second oil main from Turner Valley to Calgary will be in operation by the early autumn. About 200,000 dollars will be involved in the project, which embraces the laying of about 30 miles of pipe. The new main will be a common carrier, but will be connected up at the outset with the McLeod, McDougall-Segur, United, Spooner, and Vulcan wells. The Regal refinery, which will be served by the new main, has been getting its Turner Valley product by truck to Okotoks and rail from Okotoks to Calgary.

After paying a call at Cardiff the ship "Discovery" finally left on her voyage of exploration in the Antarctic on Saturday last, August 10th. After touching at St. Vincent, the vessel will proceed to Cape Town in order to take on board Sir Douglas Mawson, who will thereafter assume command of the expedition and other members of the *personnel*. From Cape Town she will make for Hobart, Tasmania, before actually sailing for the Antarctic. She will probably not return for some thirty months.

The number of furnaces in blast in this country at the end of July was 167, an increase of two since the beginning of the month. The production of pig iron in July amounted to 671,900 tons, compared with 657,800 tons in June and 537,800 tons in July, 1928. The production includes 208,600 tons of hematite, 283,800 tons of basic, 132,000 tons of foundry, and 21,000 tons of forge pig iron. The July output of steel ingots and castings amounted to 804,800 tons, compared with 830,900 tons in June, and 666,900 tons in July, 1928.

Toronto air mail services have been greatly extended through the starting of new lines by Canada's Postmaster-General. July 15th last saw the opening of two new services from Toronto, one to Detroit and return and the other to and from Buffalo. Both the new services are operated daily. One, a land plane service to Detroit, marks the through connection of air mails from Montreal to Detroit, with connections to Chicago and the Pacific coast. The extension from Toronto of the Montreal–Toronto service, hitherto operated, takes in Hamilton, London, and Windsor, as intervening stops. It is operated by Canadian Airways, Ltd., and the 550-mile route is covered on a schedule of less than seven hours. The other service to Buffalo is operated by the Canadian Colonial Airways, with amphibian planes.

The Dublin correspondent of *The Times*, writing under the date of August 11th, states that a special air mail will be carried from Galway to London on August 24th. The flight, which will be made by Colonel Charles Russell, formerly Chief of the Irish Free State Air Force, will be connected with the arrival of the North-German Lloyd liner "Karlsruhe" from New York and Boston. It is hoped to cover the distance between Galway and London in about four hours. The purpose of the flight is to investigate the possibilities of Galway as a terminal port for Transatlantic mails, and if the experiment succeeds the question of passenger traffic will be dealt with afterwards. There is, continues our contemporary's correspondent, a good aerodrome at Oranmore, about six miles outside Galway City, and if it is found possible to save, as is hoped, at least a day in the journey from New York to London by disembarking at Galway, a regular service from Oranmore, *viâ* Baldonnell, to Croydon may be established.

Quoting from a review of the present position of the electric light and power industries in France, which appeared in a recent issue of the *Revue d'Economie Politique*, the Paris correspondent of the *Financial Times* states that more than half the country area of France is now in possession of electric light and power, and that there is a rapidly growing tendency to utilise electricity in all forms of agriculture. Whereas in December, 1918, there were 11,000 communes or parishes in possession of electric light and power, there are now 20,907 communes electrified, or 55 per cent. of the whole of France. In the great French cities the advance in the consumption of electric power has been most striking. In Paris alone during the previous twelve-month the total number of subscribers to electric light and power increased by 9 per cent., and the consumption of current by 11 per cent. The four great light and power companies which supply the Paris district with its electric light and power last year sold to the public 1800 millions of kilowatt-hours, representing a consumption of 1,400,000 tons of coal.

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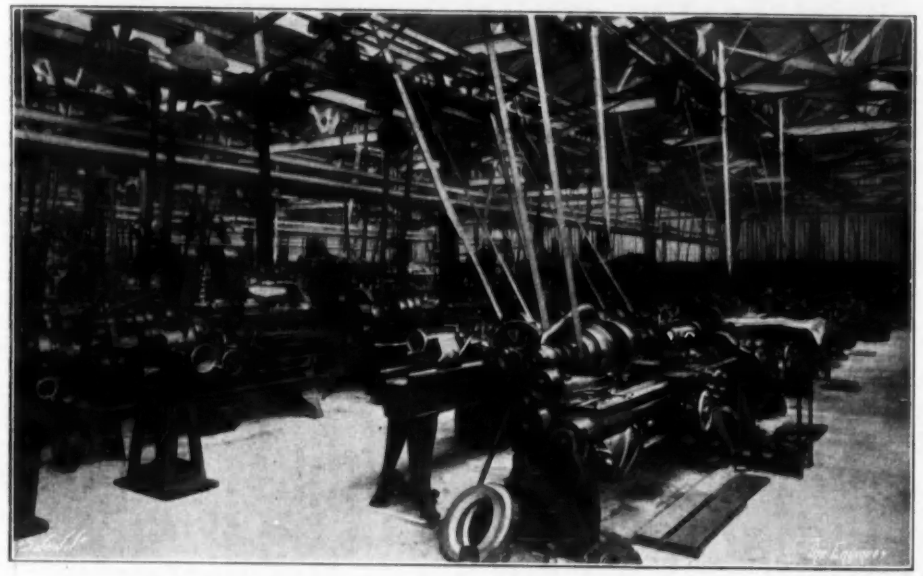

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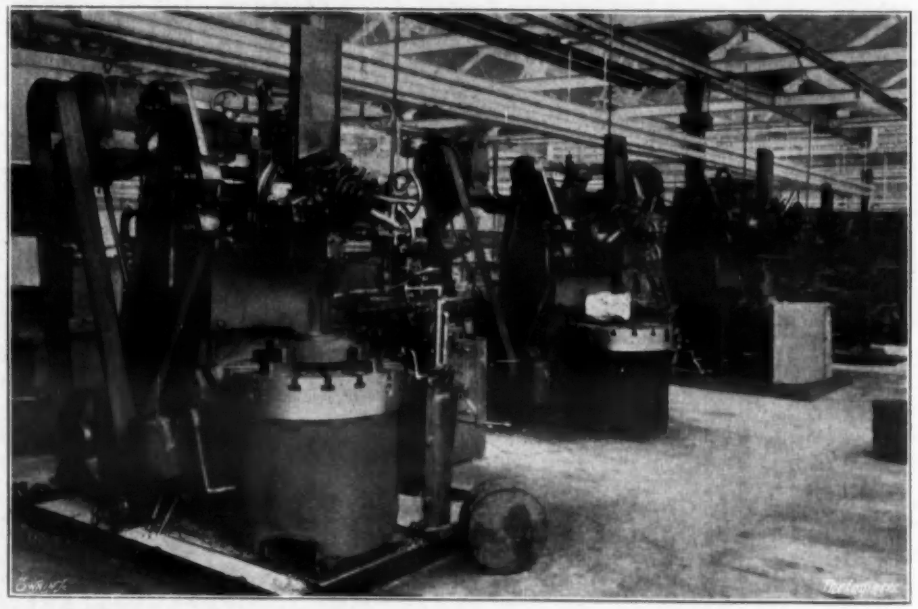

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Contents

THE ENGINEER, August 16th, 1929.

	PAGE
A SEVEN-DAY JOURNAL	161
THE RECLAMATION OF THE ZUYDER ZEE. No. II. (Illus.)	162
THE CROWN GEAR MAKING WORKS. (Illus.)	165
THE SEA	167
THE FUEL INJECTION PROCESS IN THE AIR INJECTION OIL ENGINE. (Illus.)	169
LETTERS TO THE EDITOR—	
The Ventilation of the Projected Channel Tunnel	170
MECHANISED FARMING	170
RAILWAY AND ROAD MATTERS	171
NOTES AND MEMORANDA	171
MISCELLANEA	171
LEADING ARTICLES—	
Single Lines of Railway	173
Surge Protection in Transmission Circuits	174
RAND WATER BOARD—ANNUAL REPORT. (Illus.)	174
TRANSFORMER TAP-CHANGING ON LOAD. No. VI. (Illus.)	176
THE MUMBLES RAILWAY AND ITS SIGNALLING. (Illus.)	178
MINERAL WOOL	179
SIXTY YEARS AGO	179
B.E.S.A. SPECIFICATIONS—THE PERFORMANCE OF CEILING-TYPE ELECTRIC FANS	179
THE CHADWICK TRAVELLING SCHOLARSHIPS AND THE BOSSOM GIFT SCHOLARSHIP	179
THE IRON AND STEEL INSTITUTE	179
REGIONAL PLANNING FOR NEW YORK	179
ACCELERATOR FOR HOT WATER HEATING SYSTEMS. (Illus.)	180
"AIR RIGHTS"	180
SOUTH AFRICAN ENGINEERING NOTES	180
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	181
Lancashire	181
Sheffield	182
North of England	182
Scotland	183
Wales and Adjoining Counties	183
PERSONAL AND BUSINESS ANNOUNCEMENTS	183
CONTRACTS	183
CURRENT PRICES FOR METALS AND FUELS	184
FRENCH ENGINEERING NOTES	185
BRITISH PATENT SPECIFICATIONS. (Illus.)	185
FORTHCOMING ENGAGEMENTS	186
PARAGRAPHS—	
The Lamme Medal	183
Annual Conference of the Institut International de Bibliographie of Brussels	186

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THE ENGINEER.

AUGUST 16, 1929.

Single Lines of Railway.

ALL the earliest main lines of railway were double-tracked. That was so with the Stockton and Darlington, Liverpool and Manchester, London and Birmingham, Grand Junction, Great Western, South-Western, and the lines that became the Midland Railway in 1842. In fact, it appears that only one of the main lines of to-day was originally intended to be single, namely the Lancaster and Carlisle—authorised in 1844. Even that intention was almost immediately altered as, when the Caledonian line from Carlisle to the North was sanctioned in the following year, powers were given to the Lancaster and Carlisle to double its line. Only minor lines were allowed to be single, and many empowering Acts contained a clause requiring the railway company to double them as soon as a certain specified value of traffic was reached; for instance, the Southampton and Dorchester of 1845 was to be doubled when the gross receipts exceeded £65,000 a year. The reason for that provision was no doubt the feeling that a double line was safer than a single. The fact that trains would get more quickly over the road were the line double-tracked, would not have any influence with Parliament, which was concerned only about safety. Railway companies were, however, interested in both aspects; they wanted to do their business with expedition as well as with safety. Not only, therefore, did they build their extensions in double track where such a step could reasonably be justified, but, later, doubled existing single lines. The companies, in those days, were very chary over the information they published, and presented only what they were compelled by legislation to give. Thus the Railway Returns of fifty years ago gave, under the Act of 1871, the amount of double line and the amount of single, but as the lengths of third, fourth, and other additional track are included in the double, the proportion of single line to the whole route mileage is not exactly known. It can only be said that in 1879 out of a total mileage of 17,696 there were 9671 miles of double or more tracks. We give these figures for what they are worth; they probably are quite unreliable, as most likely the "total mileage" is not the route mileage, whilst, as said, we know that the "double lines" include third and fourth running roads. About figures of to-day we are more certain, for under the Railway Companies (Accounts and Returns) Act, 1911, exact information has to be given. It is collected from the annual reports of the railway companies and embodied in the Railway Returns. From it we learn that in Great Britain, out of 24,000 route miles—*i.e.*, lengths of railway line, whether with single, double, or more tracks—there are 7632 miles or 37·41 per cent. of single track. The proportion among the grouped companies is—Great Western, 47·83; London and North-Eastern, 37·93; London, Midland and Scottish, 33·23; and Southern, 25·84 per cent.

The foregoing figures as indicating that one-third of the railway system of Great Britain has only a single line, are very instructive, and in case it may be thought that the figure is due to a large proportion of single line in Scotland, we may say that, based on the pre-grouping returns of 1922, the single-line mileage of the Scottish railways is 1635 or 60·33 per cent. of all for that country. The total figures dispel any idea that single lines are not safe; in fact, we have it on the authority of Colonel Sir John Pringle, the late chief inspecting officer of railways, that only 6 per cent. of the accidents investigated occur on single lines. That remark was made at the London Congress of the Institute of Transport in May, 1922, when Sir John read a paper on "Safety in Railway Operation." In reviewing the accidents directly caused by human failure, those which had occurred on single lines were treated separately, in order to examine the effectiveness of token working. The total number of accidents reviewed was about two hundred, and the period they covered was the ten years before the reading of the paper. The token systems referred to were the tablet of Tyer and Co., and the electrical train staff of the Railway Signal Company. A pair of token instruments is allocated to each section of single line. Every train has to have a token, the possession of which is obtained at one end by the electrical permission of the other end. When a token is obtained, no other can be withdrawn at either end until the first is restored. Sir John considered that the proportion of 6 per cent. was small, when it was remembered that the length of single-line mileage was about 20 per cent. of the whole track mileage, and remarked that it might justly be inferred, therefore, that single lines were operated under token systems with a higher degree of security than railways with two or more tracks. That point is seldom realised, though it should be self-evident, since, not only does a token system effect a direct check upon the actions of signalmen and enginemen, but the wayside signalling is simpler, and therefore less liable to be misread by enginemen. Summing up the question of operating single lines by a token system, Sir John said that it permitted the legitimate conclusion that that method of operating single lines was radically sound and reliable. Our own researches show that during the forty years that have elapsed since token working became general, only six collisions have been inquired into where token working was involved, and in only one was the system under suspicion. In the case of that accident an instrument which is now obsolete and which was made by a firm that went out of business thirty years ago, was involved. Moreover, single lines are worked more economically than double lines. That is obvious when it is remembered that as long as a train has a token it is in possession of the single line section. It needs, therefore, no signals to protect it when standing in a station in the section nor when working at a siding. Signal-boxes, signalmen, and signals are thereby saved. The economies in capital cost and permanent way maintenance are self-evident, as there is only one road bed and, except at passing places, there is only one line to keep up instead of two. Single lines are, thus, safer to operate and cheaper to maintain, so there only remains the question of traffic operation.

The great reduction in business, both in passengers and freight upon single lines is admitted, but it must also be conjectured that in many cases the density of traffic will never again be what it once was. The question then arises, Why not convert some double lines into single, and secure some of the economies possible therefrom? Careful study, we might add, of the latest developments in token working would show that there need be little, if any, falling off in the number of trains. Another means of effecting economy would be the conversion, under an Order of the Ministry of Transport,

of branch lines into light railways. Certain disadvantages, *e.g.*, in the matter of speed limits, follow from such a course, but the economies are comparatively numerous. We are prompted to mention this particular feature by what has been done on the Mumbles Railway. From an article which appears on another page of our present issue, it will be seen that its five sections of single track are adequately protected by automatic block signals which do not need track circuit, whilst the points are, under the Ministry of Transport requirements, locked when used in a facing direction, and are automatically unlocked when a train has to pass through them in a trailing direction. The line was inspected, prior to its reopening in March last after electrification, by the Ministry of Transport, and a speed of 12 m.p.h. through the turn-outs was sanctioned, which limit, after the system has had a trial, is likely to be increased.

Surge Protection on Transmission Circuits.

Few electrical problems have received more attention within recent times than that of suppressing the over voltages that occur on overhead transmission circuits. Many investigations have been undertaken in America with a view to devising ways and means of grappling with these excessive pressures which often prove a source of nuisance to operating engineers. Of the various surges which are met with and which are at the root of the trouble, those attributable to lightning are by far the most serious. Generally speaking, those set up by switching operations and by faults are much less destructive. Lightning surges are liable to cause flash-overs on transmission line insulators, and to damage transformers and other apparatus. Much of the information on surge phenomena published in America has been obtained by means of the Klydonograph, developed by J. F. Peters, who conceived the idea of using Lichtenberg figures to measure lightning voltages on transmission line circuits. Since the invention of this instrument, many important advances have been made in the study of electric surges, although the interpretation of Lichtenberg figures, as obtained by Klydonographs and surge recorders, is largely dependent on an accessory instrument, the cathode ray oscillograph developed by Professor Dufour. By means of Lichtenberg figures, produced by electrical discharges and first discovered about 150 years ago, the Klydonograph records voltage impulses of extremely short duration that give information as to polarity, magnitude, wave form, &c., of surges in electric circuits. A surge voltage recorder devised by the American General Electric Company is a modification of the Klydonograph, and gives simultaneous records of both positive and negative Lichtenberg figures.

It is scarcely possible to summarise in a few words the results of all the American investigations or to discuss at length all the opinions that are held as to how lightning surges should be dealt with. That the investigations have led to important and interesting results can, however, readily be shown. Briefly, the time for a cloud to discharge has been measured, the wave shape of natural lightning and the attenuation of lightning waves travelling on a transmission line have been determined; natural lightning waves have been reproduced in the laboratory where their effects on transmission lines, insulators, transformers, &c., have been studied. Waves from a lightning generator operating at over 3,600,000 volts have been sent over transmission circuits in order to test full-sized transformers and other apparatus. The results of this and other work should prove of no small assistance to transmission engineers, especially those responsible for the design of lines in parts where severe thunderstorms are frequently experienced. But all investigators have not arrived at precisely the same conclusions. A study of the literature on lightning surges will reveal the fact that on certain points there is diversity of opinion. While, for instance, most engineers attach importance to the protection of electrical circuits from the effects of powerful induction from nearby lightning flashes, one eminent authority at least, namely, Dr. G. C. Simpson, considers that induced charges rarely give rise to trouble. In his Kelvin Lecture, delivered before the Institution of Electrical Engineers last May, Dr. Simpson expressed the opinion that practically all harmful surges are attributable to direct strokes, and that surges arising from induction are of little practical importance. An induced charge, he explained, had not the current, potential or energy to be dangerous. A careful study of the experiments made in America, particularly with the Klydonograph, would, he thought, support the opinion that nearly all dangerous surges are attributable to direct strokes to the line. This, we believe, is contrary to the general opinion held in this country, and it is a matter of regret that those who do not share this view have remained silent. That earth wires are desirable and that the line should not be unduly high, most transmission engineers appear to agree. The ideal line, states Mr. F. W. Peek, jun., one of the leading American authorities, would be as low in height as practicable, be protected with one or more earth wires, and be insulated with insulators protected with grading shields. Sections of the line in exceptionally unfavourable positions would have extra insulation and extra earth wire protection.

A problem of no small importance is that of the protection of transformers. Flash-overs on transmission line insulators may cause damage and give rise to a temporary interruption of the supply, but a damaged transformer is a more serious matter. In nearly all cases the damage done to transformers by surges or travelling waves is brought about by the comparatively high inductance of the windings, which tends to prevent the surge discharging through the windings to earth, and causes it to build up or concentrate on the end turns. The steeper the wave front, the greater is the concentration of stress. To combat this trouble, various protective devices have been devised. The practice of increasing the insulation of the end turns has also been adopted. Some engineers have concentrated upon the improvement of lightning arresters and surge absorbers; others have pinned their faith on increasing the insulation of the end turns of transformers. Diversity of opinion as to the merits of the two schemes still exists, but improvements in protective devices have changed the ideas of many who were originally opposed to their use. Protective devices may be divided into two classes, those that operate by discharging the energy of the surge to earth and those that absorb the energy. For the absorber type—described in The Engineer of August 13th, 1928—important advantages are claimed. The stress on a transformer set up by a surge is said to be reduced to about 15 per cent. of its original value, a reduction much in excess of that generally obtainable with the usual types of lightning arresters. Added to this important feature is the fact that at no time is any part of the transmission line earthed, so that power arcs and disturbances of the supply system are not liable to follow the operation of the apparatus. While it is perhaps too early to express a definite opinion on the behaviour of surge absorbers under all conditions, experience so far gained with them in places where thunder storms are exceptionally severe seems to indicate that they are satisfactory. Unlike other devices designed for the same purpose, surge absorbers are connected in series with the line. The use of spark gaps is avoided, and the simplicity of the general construction is a feature which should appeal to those who are seeking a solution of the surge protection problem with a view to increasing the reliability of transmission systems.

Rand Water Board—Annual Report.

A copy of the Report of the Rand Water Board to the Minister of Public Health of the Union of South Africa for the year ended March 31st last reached us recently. It provides some interesting reading, as have its forerunners. It contains, first of all, as usual, the general report of the Board, which is signed by the Board's Secretary and Treasurer, Mr. J. H. Stevenson, and is accompanied by numerous balance sheets and accounts; then the Auditor's Report, and finally the Chief Engineer's Report and a collection of statistical appendices.

It is pointed out that, as stated in the Report for the preceding fiscal year, good progress had been made by the end of March, 1928, with the works described as portion "B" of the second unit of the Vaal River scheme, which was authorised by the Board in May, 1927. The original Vaal River scheme was sanctioned in 1916. It will be remembered that the full scheme embodied the construction of a barrage across the Vaal River and the laying down of works for the abstraction and purification of 20 million gallons of water per day and the delivery of that volume by pumping into the Board's distribution system. The scheme was not carried out in its entirety in the first instance. It was decided that, as a first instalment, only 10 million gallons per day should be abstracted from the river and taken into service. That instalment, again, was subdivided into two parts or units of 5 million gallons each. The first unit was completed and put into operation in July, 1923. In May of the following year it was decided to put in hand portion "A" of the second unit, and that part of the undertaking was completed in August, 1926. By it an additional 5 million gallons of water per day were made available at the Zwartkopjes Pumping Station. The works comprising portion "B" of the second unit were sanctioned in the early part of the year 1928. They were described in detail in our issue of August 17th of that year, so that only an outline of them need be given in the present instance. As originally designed they consisted in the installation of additional plant at Zwartkopjes Station and the laying from that station to the Village Pumping Station at Johannesburg of a pipe line capable of delivering into the Board's central distribution system, against a head of 1000ft., the extra 5 million gallons a day obtained from the Vaal. The scheme as finally carried out provided, in addition to the works already specified, for the extension of the pipe line from the Village Pumping Station to the Johannesburg Municipality's High Service Reservoir at Yeoville, and the alteration in the design of the pumping plant at Zwartkopjes so as to make it capable of delivering the 5 million gallons per day into that reservoir. The pumping machinery comprised two steam-driven turbo-centrifugal pumps capable of operating against a head of 1175ft., and a considerable quantity of additional pipe line had to be laid. The laying of the pipe line was completed in September, 1928, but some delay occurred in the delivery of the additional pumping machinery, with the result that that plant was not handed over to the Board by the contractors until January of this year. However, by the end of March, that is at the end of the period covered by the Report, the scheme had been completed in all its essential features, though some minor works incidental to it still remained to be carried out. The estimated cost of the undertaking was about £165,000, and the Report states that, actually, it will be found to have cost some £4350 less than that sum. As a result of the completion of this Portion "B" of the Second Unit of the entire scheme, the Board is now in a position to reticulate the whole of its available water.

Concurrently with this work, the Board carried out a scheme for the improvement of its distribution mains on the Far East Rand. Some 29,280ft. of 18in. diameter pipes in the Zwartkopjes-Leeuwpoort main were replaced by 22in. diameter pipes, which had the effect of increasing the capacity of the main from 4·2 to 6 million gallons a day. Of the 18in. pipe recovered as a consequence, 18,023ft. were laid from Dunswart to Benoni Reservoir in replacement of the 12in. main originally laid between those points. These works, which were estimated to cost £49,415, were completed during the year at an actual cost of £45,070.

The quantity of water available at each of the Board's sources of supply remained constant throughout the year as follows:—

	Million gallons per day.
Vaal River	10·4
Zwartkopjes and Zuurbekom	10·0
Local stations	0·1
Total	20·5

During the year, however, the demands of the consumers only necessitated an average daily volume of only 15·85 million gallons per day to be pumped, of which the Vaal River provided 9·52 million gallons, the bore-holes in the Zwartkopjes area of the Klip River Valley 1·78, and the Zuurbekom area 4·49 million gallons respectively, while the new Doornfontein bore-holes yielded 0·06 million gallons. The Report explains that, though there was no actual shortage in the supply to consumers, some difficulty was experienced in maintaining the pressures in the distribution mains during periods of high demand in the early summer months of the year. With the completion of Portion "B" of the "Second Unit" of the Vaal scheme, however, including the pipe line alterations already alluded to, the difficulties were removed. The daily consumption of water during the year varied between a maximum of 20·38 million gallons—which occurred on December 21st last—and a minimum of 10·58 million gallons, which is recorded for June 3rd last year. It is explained that the loss of water due to leakage and wastage amounted during the year to 2·118 per cent., as compared with an average during the last twenty years of 4·558 per cent.

The quantity of water raised during the year was 5,784,864,000 gallons, which represented an increase of 150,000,000 gallons as compared with the previous year. The quantity actually sold was 5,539,589,601, as compared with 5,424,179,100 the year before, an increase of 115,410,501 gallons. The increased demand made by the municipalities was 144,442,200 gallons above the previous year, but, on the other hand, the demand made by the mines fell off by 64,653,300 gallons, though there was an increase of 1,111,000 tons in the quantity of ore milled. The railways showed an increased demand. The water sales of the Board since its inception are shown graphically in Fig. 1, which is reproduced from the Report. The population within the Board's limits of supply was 617,325, made up of 275,386 Europeans and 341,939 non-Europeans. The municipal area within the limits of supply reaches 422·88 square miles, with a total population of 605,823, made up of 262,771 Europeans and 343,052 non-Europeans.

The total tonnage of coal delivered to the various

pumping stations during the year was 78,389 tons, as compared with 78,526 tons delivered during the previous year. The total cost of the coal delivered at the railway stations and sidings serving the various pumping stations was £25,000, which was £2209 less than the amount paid the year before. The average price paid was 6s. 4·54d. per ton, as compared with 6s. 11·16d. in respect of the previous year. This decrease of 6·62d. per ton is attributed to a lower average evaporative duty of the coal. The cost of transport of the coal from railway stations and haulage over sidings to the various pumping stations is given as being £1825, or 5·58d. per ton, as compared with £2212, or 6·7d. per ton, or 1·18d. per ton less than in the year before. The total cost of the coal delivered at the coal bunkers was, therefore, £26,825, as compared with £29,421 for the previous year. That gives an average of 6s. 10·12d. per ton, as compared with 7s. 5·92d. in the year before, a decrease of 7·8d. per ton.

The total cost of the water per 1000 gallons based on the quantity sold was 7·088d., as compared with 6·892d. during the previous year. The cost of pumping and maintenance only was, on the same basis, 4·8259d., as compared with 4·8203d. for the previous year. The cost of water per 1000 gallons raised 100ft. was 0·19d., as compared with 0·2052d. for the previous year, or a decrease of 0·0152d. per 1000 gallons raised 100ft., which reflects the improvements made in the Board's system during the year. The "Fixed Charges" for the year ended March 31st last represented a rate of 13·95d. per 1000 gallons on the basis of the supply to all consumers during that period averaging 15·17 million gallons a day. The inclusive unit cost to the Board of supplying that quantity was, therefore, 21·03d.

The question of costs is graphically illustrated in Fig. 2, also reproduced from the Report, which covers the years 1905 to date. The various curves show: (*a*) the total cost of pumping; (*b*) the cost in pence per 1000 gallons; (*c*) the total cost of maintenance; and (*d*) the cost of maintenance per 1000 gallons.

The Board is debarred by its Statutes from making any profit out of the sale of water to its consumers, so that the figure 21·03d. represents the average unit cost to all consumers of water purchased by them from the Board during the period under review. It is explained in the Report, however, that regarded from the point of view of the cost of water to the consumer, the statutory incidence of the "Fixed Charges" causes a variation in the inclusive cost per 1000 gallons in the case of each of the different sections of the Board's consumers. The Statutes provide (i.) that the Board shall charge for water supplied by it to all consumers an *uniform* rate sufficient to meet the working costs, and (ii.) that, in addition to the *uniform* rate, the Board shall charge the following special rates for water supplied to:—

(*a*) Gold producing mines a *special* rate of such amount that the total of the *uniform* and *special* charges shall be 1s. per 1000 gallons when the *uniform* rate is 6d. or under; 1s. 3d. per 1000 gallons when the *uniform* rate is 7½d. or over; and equal to twice the *uniform* rate where the latter is between 6d. and 7½d. per 1000 gallons.

(*b*) Consumers other than local authorities, gold-producing mines and the Railway Administration, a *special* rate of not less than three times and not more than five times the amount of the *uniform* rate.

The *uniform* charge in force during the first six months of the year under review was at the rate of 7½d. per 1000 gallons. As from October 1st, 1928, that rate was reduced to 7d. per 1000 gallons, and, actually, a further reduction to 6½d. was brought into force for April 1st last. It is explained in the Report that, whilst these reductions in the *uniform* rate are, to some extent, due to the continued steady increase in the quantity of water sold annually by the Board, they are largely attributable to the economies in working costs resulting from the improvements in the Board's distribution system and the completion of the scheme—carried out under Portion "B" of the second unit of the Vaal River scheme—for pumping direct from Zwartkopjes Pumping Station to the Yeoville Reservoir. This direct pumping scheme has enabled the Paarlshoop and the Village Pumping Stations to be put out of regular service, so that they need only be brought into commission in cases of emergency. Accordingly their original steam-driven pumps have been replaced by modern electrically driven pumps, the power to operate them being purchased from Johannesburg Municipality as and when required.

The capacity of the Board's reservoirs at its pumping stations and on the Rand are as follows:—

Reservoir.	Million gallons.
Zwartkopjes	12·500
Vereeniging	5·000
Krugersdorp	1·389
Paarlshoop	0·530
Forest Hill	5·000
Signal Hill	2·500
Benoni	2·500
Total	29·419

The reservoirs at Leeuwpoort, Simmer and Jack and Turffontein, the combined capacity of which is 4·324 million gallons, have become inoperative with the changes in the Board's system. The reservoir at the Village Pumping Station, the capacity of which was 1·261 million gallons, has been demolished, the reorganisation of the central area reticulation under the gravitation head from the Forest Hill Reservoir, which was dealt with in the last Report, obviating the need for a reservoir at that point. In addition to the reservoirs set out in the above list, there are certain reservoirs which belong to, and are under the control of, Johannesburg Municipality. Their capacities are as follows:—

Reservoir.	Million gallons.
Brixton	1·268
Beres	0·960
Yeoville	3·906
Yeoville (new)	10·239
	16·373

The total length of pumping and gravitating mains in the Board's system was, on March 31st last, 260 miles, while the total length of collecting mains from shafts to main pumping stations was 24 miles.

The total discharge of the Vaal River at the Barrage during the year was 291,190 million gallons, which would have been sufficient to have filled the reservoir about twenty-one times. The capacity of the reservoir formed by the barrage is 13,633 million gallons. The heaviest flood experienced during the year was on March 13th last, when 15,444 million gallons of water passed the barrage during the twenty-four hours.

The rainfall during the year under review appears to have been, as a whole, below the average. In the table below are set out (*a*) in the second column the average in the various Sections of the Witwatersrand over a period of twenty-five years; (*b*) in the third column the actual rainfalls in each of the same districts for the year under review; and (*c*) in the fourth column the percentage amount above or below average in each case.

Rainfall Statistics.

	Average inches.	Actual, inches.	Percentage above or below average.
Eastern Section	28·60	27·15	−5·07
Central Section	30·29	27·95	−7·72
Western Section	28·20	29·17	+3·44
Southern Section	27·57	26·80	+2·80

The rainfall for the year at the Barrage was 23·02in.

THE Road Vehicles return of the Ministry of Transport for the six months ended May 31st last has been issued as a Stationery Office publication. It shows that, excluding tramcars, there were on the date named 2,027,000 motor vehicles, which figure includes 918,000 cars taxed on horse-power, 670,000 motor cycles, 312,000 motor goods vehicles, and 68,000 motor hackneys. The gross amount received for licences during the six months was £20,312,028. The return includes details of the numbers of each class of vehicle newly registered by each licensing and registration authority, and an analysis of the principal classes according to the various taxation scales.

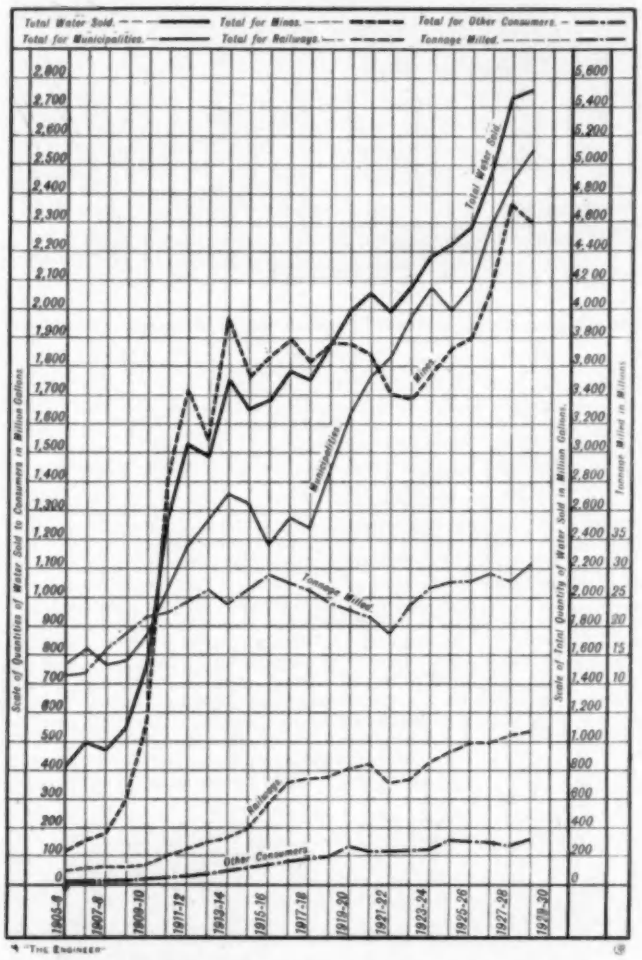


FIG. 1—CONSUMPTIONS OF WATER AND TONNAGE MILLED

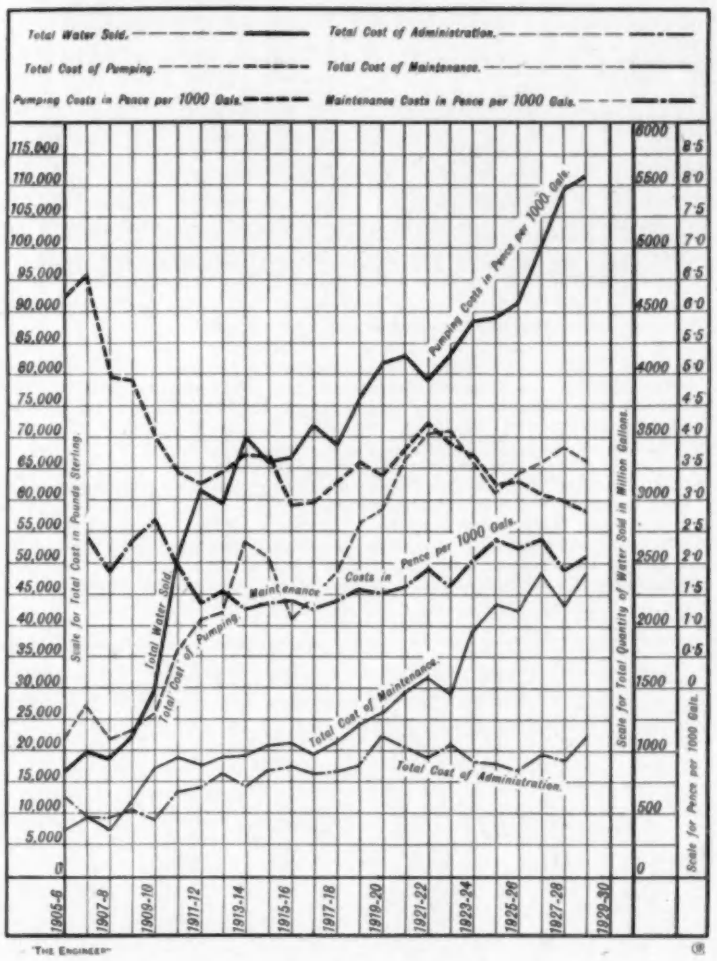


FIG. 2—PUMPING, MAINTENANCE AND ADMINISTRATION COSTS

Transformer Tap-Changing on Load.

No. VI. (*conclusion*).*

The English Electric Co., Ltd.

From the foregoing articles it will have been gathered that the mid-point auto-transformer or external reactance method of tap changing under load is the one generally adopted. Only one British firm has at present constructed large on-load tap-changing transformers operating on the internal reactance or parallel winding principle, and that firm also employs the auto-transformer method.

The English Electric Company's on-load tap-changing transformers all operate in accordance with the latter scheme, the number of tappings corresponding to half the number of voltages required. The tappings are brought out through the side of the transformer tank, and are connected through contactor gear to the auto-transformer in various combinations, the permanent outgoing connection being from the mid-point of the auto-transformer. On odd voltages the path of the current is through a single tapping, and one-half of the auto-transformer to the mid-point. For even voltages adjacent pairs of tappings are connected across the auto-transformer, the mid-point giving a voltage midway between those corresponding to the pair of tappings on the main transformer. The contactor gear—see Figs. 46 and 48—is operated by a series of cams on the well-known "English Electric" controller principle, and a quick action is ensured by the cams being double acting and actuating a toggle mechanism; moreover, the sequence and timing of the opening of the contactors is absolutely definite. An oil-filled chamber bolted to the transformer tank—see Fig. 46—contains the whole of the contactor and cam shaft gear. From a motor-operated mechanism—Fig. 49—mounted on top of the contactor chamber, the cam shaft is operated through bevel gearing. A crank operates a tooth wheel mechanism, and makes a complete revolution for each tapping change, but the actual operation of the contactors is performed during a movement through 70 degrees. On the crank shaft and rotor, operated from the mechanism, is connected by only two or three wires to an instrument designed on the lines of a power factor meter, which may also be mounted on the control board. Each tapping change results in the phase shifter being moved through a certain angle, and thereby causes the indicating instrument to move a corresponding amount, thus indicating the various tapping positions. While the scheme (*a*) is direct and simple, it involves the use of a large number of tapping wires, which, when the distance between the control board and transformer is great, become expensive. The scheme (*b*), on the other hand, only calls for two or three pilot wires. In the control-room a lamp and buzzer give indications to the attendant whilst a tap-changing operation is occurring, and if the operation is not completed these indications continue. In sub-stations, where there are two or more transformers, the control circuits allow each unit to be operated individually, and in the event of all the units being connected in parallel, all the tap-changing equipments can be controlled simultaneously from one of the control switches, which are of the "spring return to neutral type." The switch is moved in one direction when it is desired to raise the voltage, and in the opposite direction when it is desired to lower it. All the operator has to do is to move the switch in the proper direction and to release it. The movement of the switch only requires a fraction of a second, whilst the tap-changing process is completed in slightly over two seconds.

Where it is considered desirable to ensure that an operator shall not connect two transformers in parallel on different tappings, a more elaborate control system can be provided. The circuits are arranged so that when the attendant desires to put a second transformer in parallel with one already on load, it is impossible for him to close the main circuit breakers until the terminals of the incoming transformer are connected to the same tappings as those of the unit already in service. First of all, the attendant closes a paralleling switch, which causes the tap-changing gear of the incoming transformer to operate until the tappings are adjusted to correspond with those of the working transformer. Then, and not before, the main circuit breakers can be closed. When the two units have been connected in parallel, the tap-changing equipment belonging to both units are operated from a single control switch, and the circuits are arranged so that in the event of the operator starting a combined tap change and one unit failing to respond, the other unit returns to the original position, thus maintaining the two transformers in tapping synchronism.

The diagram—Fig. 50—shows the complete scheme of connections for controlling the operating mechanism on the transformer from a distance, and for giving indications and alarms at the control point. The gear mounted on the control panel is to be seen on the left, the equipment mounted on the transformer in the centre and a small amount of equipment, which for convenience may be situated in an auxiliary room on the transformer site, is shown on the right of the diagram. The diagram relates to a transformer station comprising two duplicate units. For the supply of current for the operation of the gear, an auxiliary transformer is provided for each unit, and by means of selector switches each auxiliary transformer can be connected to either or both of the main units. Each transformer has a control switch of the "spring return to neutral" type, which operates in either direction to raise and lower the voltage, and, as already explained, it is only necessary to move this switch through a small angle, and then to release it, in order to set the tap-changing gear in operation. By means of these two control switches, the two units can be operated entirely independently, but when the two units are in parallel they are controlled simultaneously by control switch No. 2. For use when it is desired to change from solo to combined operation of the two units a control selector switch is provided.

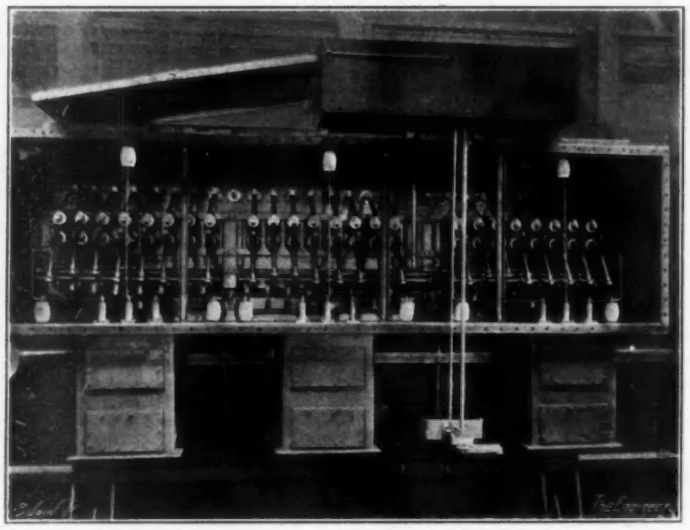


Fig. 46—Tap-Changing Contactors

Fig. 47—15,000-kVA. 132-kV 3-Phase Transformers Removed from Tank

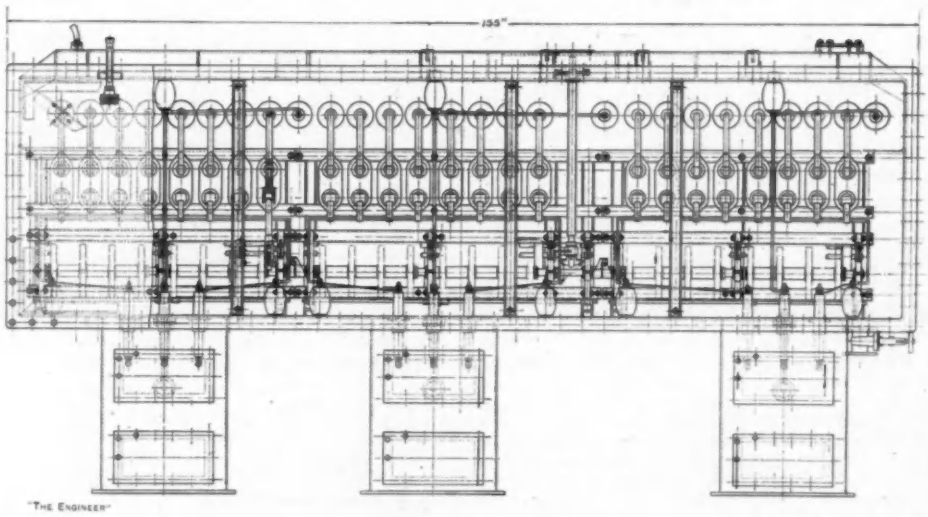


Fig. 48—Cam-Operated Contactor Gear

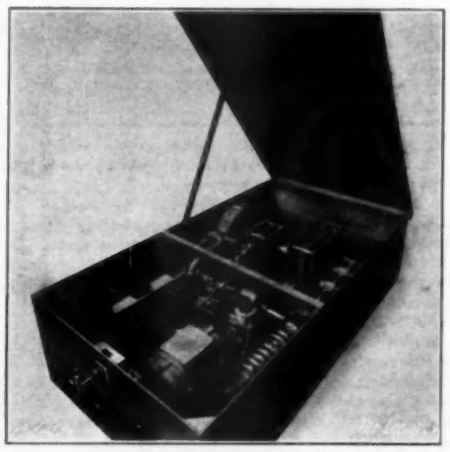


Fig. 49—Motor-Operating Gear

* No. V. appeared August 9th.

If it should be desired to operate the mechanism electrically at the transformer, it is necessary to isolate the remote control circuits in order to protect the operator on site and for this purpose a change-over switch is provided on the transformer. When moved to the local control position, this switch isolates the remote control circuit and then makes the local control switch available for use. After the change-over switch has been moved to the local control position, a key is released for opening the main motor operating mechanism box. In this way the mechanism can be operated on site for testing purposes or under emergency conditions without any danger of the gear being set in motion from the remote control panel. Tapping-indicating switches associated with the operating mechanism are connected through pilot wires to indicating lamps mounted on the control panels, but, as already mentioned, where the length of multi-core cable would be great the phase-shifting scheme is adopted. If the tap-changing operations of two units should get out of step the attendant is advised of the fact by an indicator and alarm at the control point. For this purpose each transformer is provided with an additional switch, and these switches are coupled so that the alarm and indicator are operated under the above conditions. When the fan that supplies air for cooling the transformers is put into operation, a lamp lights up on the control, and an alarm is set into operation in the event of the fan motor being put out of action. Alarm contacts of thermometers mounted on the transformers are connected to alarm circuits on the main control panel. For all the alarms a small telephone board type switch is provided, which is used to break the alarm circuit after the alarm has been given, and the fact that the alarm circuit has been put out of action is indicated by a lamp on the control panel. The English Electric Company is manufacturing a large number of transformers with a load tap-changing gear with outputs up to 20,000 kVA, and for pressures of from 11,000 to 132,000 volts. Fig. 47 shows a 15,000-kVA, 132,000-volt, 3-phase transformer, which is being made for the Central Scotland Electricity Scheme.

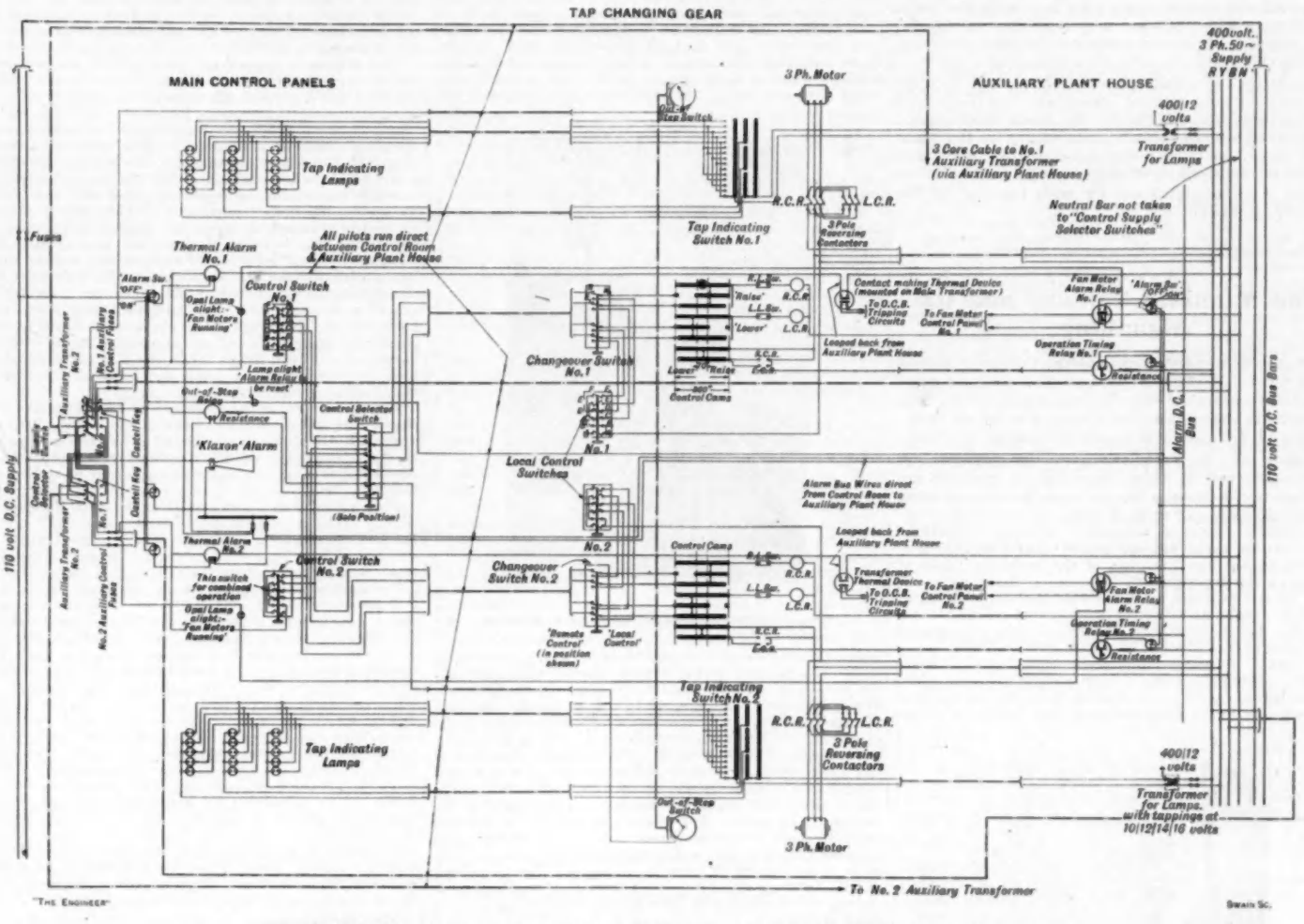

TAP CHANGING GEAR
MAIN CONTROL PANELS
AUXILIARY PLANT HOUSE
3 Ph. Motor
400volt. 3 Ph. 50~ Supply R Y B N
400/12 volts
Transformer for Lamps
3 Core Cable to No. 1 Auxiliary Transformer (via Auxiliary Plant House)
Neutral Bar not taken to "Control Supply Selector Switches"
Tap Indicating Lamps
Out-of-Step Switch
Tap Indicating Switch No. 1
R.C.R.
L.C.R.
3 Pole Reversing Contactors
Fuses
Thermal Alarm No. 1
All pilots run direct between Control Room & Auxiliary Plant House
Control Switch No. 1
Changeover Switch No. 1
Contact making Thermal Device (mounted on Main Transformer)
To O.C.B. Tripping Circuits
To Fan Motor Control Panel No. 1
Fan Motor Alarm Relay No. 1
Operation Timing Relay No. 1
Resistance
Looped back from Auxiliary Plant House
Control Cams
Out-of-Step Relay
Control Selector Switch
'Klaxon' Alarm
Local Control Switches No. 1
Local Control Switches No. 2
(Solo Position)
Alarm Bus Wires direct from Control Room to Auxiliary Plant House
Alarm D.C. Bus
110 volt D.C. Bus Bars
110 volt D.C. Supply
Thermal Alarm No. 2
Control Switch No. 2
Changeover Switch No. 2
Transformer Thermal Device
To Fan Motor Control Panel No. 2
Fan Motor Alarm Relay No. 2
Operation Timing Relay No. 2
'Remote Control' (in position shown)
'Local Control'
Tap Indicating Switch No. 2
Tap Indicating Lamps
3 Pole Reversing Contactors
400/12 volts
Transformer for Lamps, with tappings at 10/12/14/16 volts
To No. 2 Auxiliary Transformer

FIG. 50—ENGLISH ELECTRIC TAP-CHANGING SYSTEM ARRANGED FOR REMOTE CONTROL

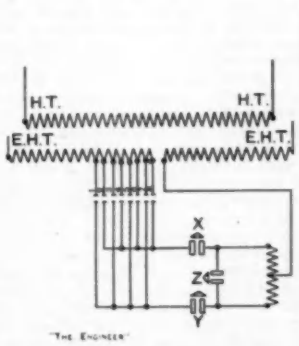
The General Electric Co., Ltd.

At the moment we are not in a position to give a very detailed description of the General Electric Company's scheme—at any rate, not of the mechanical part of the scheme—but we hope to be able to publish something more informative later. Briefly, this company's system of tap changing under load involves the use of a tapped auto-transformer, and stored mechanical energy is utilised for operating the gear. Once a change in the connections has been begun, it is completed even if the power fails. Gearing connects the device to a slowly moving shaft, which operates the various switches in the correct sequence. Energy from this system is used for operating a combination of selector and diverter switches, which are connected to tappings on the transformer at, or near, the middle of the winding. The diagram, Fig. 51, shows the transformer windings, tappings and switches, for an eight tapping or fifteen step equipment, and on the right of this diagram is a table showing the sequence of operation of the switches. On step 1, with the minimum amount of winding included, switches X, Y and Z are closed. To obtain the next step, equivalent to a tapping half-way between 1 and 2, switch 2 is closed, switch Z opened and switch X closed. The succeeding steps will readily be followed from the key table, in which a circle surrounding a letter or figure signifies "closed."

The gear coupled with motor and hand operation mechanism is contained in a tank at the side of the transformer tank, and it can be inspected and repaired without lifting the transformer from its container. If necessary the equipment can be detached from the transformer for the purpose of transport. The motor, which is mounted at the side of the switch, drives the mechanism at a speed sufficient to ensure that a tap-changing cycle is completed in approximately ten seconds. The actual change, however, is almost instantaneous, the remainder of the time being taken up by preparatory movements. For actuating the equipment in the case of emergency hand gear is provided. The selector switch contacts are of the knife type, and are conservatively rated, so that they can operate satisfactorily over long periods. The oil switches which actually break the circuit are designed in accordance with the best circuit breaker practice. They are isolated from the selector switch tank, and means are provided for lowering the oil container for inspection. Care has been taken to avoid oil leaks, especially at those places where moving shafts are brought outside the switch case, but the use of glands has been avoided.

It will be seen that the use of the auto-transformer in the manner described enables an additional voltage step to be obtained mid-way between the actual transformer tappings. The circuit is made or broken on the three switches X, Y and Z, which as explained, are of the oil break type. The selector switches 1–8 are oil immersed, but it will, of course, be understood that they do not make or break the circuit whilst it is carrying load. When the auto-transformer is connected to a single tapping it is short-circuited. This, the makers point out, is desirable, as it gives equal voltage steps and avoids complications and uncertainties in the design of the auto-transformer.

The gear is suitable for push button remote control by the use of a multi-core cable, remote supervisory control, by the use of two pilot wires, and automatic control by relay. The automatic gear is "self-levelling," that is to say, it automatically adjusts the ratio of the incoming transformer to the ratio of the transformer already in load. All transformers working on load are compelled to work on the same tapping, and any change of ratio must be carried out on all transformers simultaneously. A unit that is taken off load for any reason has its tap-changing mechanism cut out of action automatically, so that it no longer moves in synchronism with the units that remain on load. On attempting to put the unit back into service it adjusts its tappings so that the transformer has the same ratio as those on load, and finally switches itself in, and this sequence of operations results from



	Step 1	Operation	Step 2	Operation	Step 3	Operation	Step 4
	① Ⓨ Ⓩ	② z Ⓧ	① Ⓨ ② Ⓧ	Y Ⓩ 1	② Ⓧ Ⓩ	③ z Ⓨ	② Ⓧ ③ Ⓨ
Operation	Step 5	Operation	Step 6	Operation	Step 7	Operation	Step 8
x Ⓩ 2	③ Ⓨ Ⓩ	④ z Ⓧ	③ Ⓨ ④ Ⓧ	Y Ⓩ 3	④ Ⓧ Ⓩ	⑤ z Ⓨ	④ Ⓧ ⑤ Ⓨ
Operation	Step 9	Operation	Step 10	Operation	Step 11	Operation	Step 12
x Ⓩ 4	⑤ Ⓨ Ⓩ	⑥ z Ⓧ	⑤ Ⓨ ⑥ Ⓧ	Y Ⓩ 5	⑥ Ⓧ Ⓩ	⑦ z Ⓨ	⑥ Ⓧ ⑦ Ⓨ
Operation	Step 13	Operation	Step 14	Operation	Step 15		
x Ⓩ 6	⑦ Ⓨ Ⓩ	⑧ z Ⓧ	⑦ Ⓨ ⑧ Ⓧ	Y Ⓩ 7	⑧ Ⓧ Ⓩ		

FIG. 51—CONNECTIONS AND SEQUENCE DIAGRAMS FOR G.E.C. TAP-CHANGING SCHEME

the momentary closing of a push button or key or from the operation of a relay. All necessary precautions are taken to prevent the incoming transformer being connected to the load in the event of it failing to "level" itself correctly, and the whole of the gear is foolproof. A separate switching arrangement enables each transformer to be isolated and operated by a push-button over its full range for testing and other purposes. All the parts of the tap-changing gear, with the exception of the tappings themselves, are housed in separate tanks attached to the main tank, and it is therefore an easy matter to isolate all the tap-changing gear and keep the main transformer available for service. The oil in the main transformer cannot, of course, be affected in any way by the operation of the tap-changing gear.

To sum up, the features to which the General Electric Company directs special attention are:—(1) All moving parts are external to the main transformer; (2) protective equipment is unnecessary on the main transformer, as during the tap-changing operation there is no overloading of the windings; and (3) two voltage steps are obtained for each tapping on the main transformer.

The Mumbles Railway and Its Signalling.

The Mumbles is the oldest passenger-carrying railway in the world. Illustrations are extant of the conveyance of passengers on it in 1816. Because it has recently been converted to electric traction, it had to be offered to the Ministry of Transport for inspection. Before that could be done it had to be signalled, and that work is now described, because it offers suggestions to tramway and light railway authorities for the more speedy and more economical operation of their lines.

Interest in early railway history has recently been revived by the electrification of the Mumbles Railway, which, as the Oystermouth Railway or Tramroad, and, later, as the Swansea and Mumbles Railway, was sanctioned in 1804. As related in the series of articles, "One Hundred Years of British Railways," which appeared in The Engineer for the second half of 1924, many "rail-ways," "rail-roads," "tram-ways," and "tram-roads"—then usually spelt with a hyphen—were sanctioned before the first public railway—the Surrey Iron Railway—in 1801. Between that year and 1821, when

Fig. 1—Illuminated Disc-Type Signal

the Stockton and Darlington was authorised, parliamentary powers were obtained to build no less than thirty railways. That list included not only the Surrey Iron Railway and its companion, the Croydon, Merstham and Godstone, but eight lines to be built by canal companies.

All the railways, with one exception, made prior to the opening of the nineteenth century, were constructed by canal companies. Singular to relate, that exception was the very first railway for which an Act of Parliament was obtained—the Middleton tramway, outside Leeds. That was sanctioned in 1758. John Blenkinsop worked on that line and it was there that his engine was tried in 1811. The second railway to be authorised was the Trent and Mersey Navigation Company's line from the canal at Froghall to the limestone quarries at Caldon. That, again, has a history of its own. The Trent and Mersey Navigation was acquired by the North Staffordshire Railway when that line was authorised in 1846—it might almost be said that the Navigation built the railway, as the promoters of the railway were the proprietors of the canal—and so the Caldon Quarries also passed to the North Staffordshire Railway. The output to-day is over half a million tons of limestone annually. They appear now in the London, Midland and Scottish annual report as having incurred a capital expenditure of £43,334, and in the account of "receipts and expenditure on other businesses," they are shown as having earned last year £34,578, at an expenditure of £33,212 or a profit of £1366.

Coming now to the Oystermouth Railway we may note that it was the fifth public railway to be sanctioned; its four pedecessors were: Surrey Iron Railway, 1801; Carmarthenshire, 1802; Sirhowy, 1802; Croydon, Merstham and Godstone, 1803. The Oystermouth Railway Act of June 29th, 1804, authorised the making and maintaining of a railway or tramroad for the passage of "wagons and other carriages" from the Swansea Canal at Brewery Bank at Swansea to Castle Hill in Oystermouth; a branch from the Mount in Swansea to Swansea Pier, and a branch from Black Pill to Ynys. The line was opened in 1807.

A feature of the empowering act was that the "haling or drawing" of the wagons and other carriages was to be done with "men, horses or otherwise." Though, as said above, there were powers to convey "carriages," there was no authority to carry passengers, *i.e.*, to charge fares. A contemporary print shows a horse-drawn stage-coach used on the railway in 1816, and Brewster's *Edinburgh Encyclopædia* of 1824 said that "at Oystermouth a stage coach plies daily with passengers which appears to be its chief trade." In 1877 steam traction by tramway engines was introduced, and in 1892 by railway tank engines. Later the name was changed to the Swansea and Mumbles Railway when it was extended to Mumbles, where a deep water pier was built. In 1899 the whole property was

Fig. 2—Spring-Operated Loop Points

leased to the Swansea Improvement and Tramways Company—a subsidiary of the British Electric Traction Company—and in 1927 the lease was transferred to the South Wales Transport Company, Ltd., which operates the local omnibus services. The conversion of the line from steam operation to electric traction was sanctioned by a Ministry of Transport Order in 1925. The Swansea terminus of the Mumbles Railway is in Rutland-street, but rail communication extends to the docks. The other end of the line is at the Pier Station, Mumbles, and the length of the railway is 5½ miles. For about one-half of the distance from Swansea the railway runs by the side of the main road to Mumbles, and, under rights enjoyed from its early days, is not fenced off from the highway. The remainder of the distance has been constructed, or reconstructed, during recent years, and runs by the seashore on its own right-of-way.

Power for the operation of the trains is supplied from a sub-station, at Blackpill, erected to the designs of Mr. Ernest Morgan, the architect to the Swansea Corporation. The equipment was supplied by the Metropolitan-Vickers Electrical Company, Ltd., and consists of two rotary converters, each of 500 kW capacity, with their transformers, and provision is made for a third set. The high-tension current, at 6600 volts, is supplied from the Swansea Corporation main generating station, and when the high-tension switch at the latter is closed the rotary converters at the sub-station are switched in automatically. Current is supplied to the line at 650 volts. The overhead wires are staggered, diamond fashion, in order to prevent grooves being cut in the pantographs. The system of suspension is novel also, as no catenary wire is used, but bridles are employed at each point of suspension so as to give a flexible overhead conductor. Traction current return is through the running rails, which are reinforced by a pair of disused running rails. These lie in the "four-foot" except at the intermediate sidings, where the rails of the sidings assist in the return. The current for the signalling is taken directfrom the trolley circuit.

The cars are double-decked, top-covered, seat 106 passengers—forty-eight inside and fifty-eight on the upper deck—and are probably the largest such cars in the country. They were constructed by the Brush Electrical Company, Ltd., and fitted with two motors of 60 H.P. of the British Thomson-Houston Company's manufacture, which firm also supplied the automatically-controlled electrically-operated air compressors, which furnish air for the brakes and the alarm whistle. The collectors were provided by Brecknell, Monroe and Rogers, Ltd., and are of the bow type fitted to pantographs. The cars can be driven singly or coupled together.

The railway has been relaid—mostly with new 85 lb. rails—and re-sleepered. The sleepers are laid in hard limestone ballast. Additional passing places have been provided, and there are now five passing loops. These are usually 60 yards clear in length. A new car depôt has been erected at Rutland-street. There are eight intermediate stations. The speed limit sanctioned by the Ministry of Transport is 30 miles per hour, and the train service allows for the whole distance to be covered in 22 minutes, with an interval of from seven to ten minutes between following trains.

The signalling has been carried out by the W. R. Sykes Interlocking Signal Company and consists of absolute block automatic signals of the illuminated disc type—Fig. 1—and of the loop points, which are spring worked, being fitted with automatic facing point locks—Fig. 2—which keep them normally bolted for vehicles passing over them in a facing direction, but are unlocked for a trailing movement when the outgoing car depresses the bar seen in the rear of the points. Below, and on the opposite side to, the automatic signal is a signal which indicates whether or not the points are correctly set for a facing movement.

The automatic signals are provided for the protection of the single-line sections, of which there are five. There are thus ten signals in all, namely, an eastbound at the Swansea end of each crossing loop and a westbound at the Mumbles end of the loop. Each signal has a single glazed opening, about 12in. diameter, which faces towards the loop. Within the signal case are two translucent discs—a red and a white—which, when the single-line section ahead is unoccupied, lie vertically inside the case. When the section has been "engaged" for a departing train the white disc is raised by an electro-magnet in the case and appears in the opening; when the section has been "engaged" by a train from the opposite end of the single-line section the red disc is exhibited. In alignment with the opening are lamps which illuminate the discs, by day as well as by night, and these lamps are switched in when a disc rises. The lamps are in duplicate. Should one go out the poorness of the indication would intimate what had happened; if both lamps failed the disc could clearly be seen by day, whilst at night the headlight on the car would shine on it.

Reference, now, to the diagram Fig. 3 of a typical section shows that at the eastbound end of the passing loop A is a signal S A and at the westbound end of the passing loop B is a signal S B. On the overhead wire in the rear of signal S A is a special length of conductor or trolley contact wire which is the "on" contact A1. There is a corresponding "on" contact B1 in the rear of signal S B at B. Within the loop at B is an "off" contact B2, and there is a corresponding "off" contact within the westbound loop at A. The signals consist of a polarised relay R A for westbound trains and R B for eastbound; a Z armature electro-magnet I for operating the red disc; a Z armature electro-magnet II for operating the white disc; a lock, with electro-magnet III, engaging with the red disc carrier when that disc has been brought into view so preventing the disc from falling to normal when its Z magnet is de-energised, or should the current fail, unless the lock has been released. There are also contacts S1, which are operated by the red discs and closed when they appear, and S2 which are operated by the white discs and closed when they are normal. Contact S2 opens directly the respective white disc rises and interrupts the circuit of the red disc Z magnet I in the same signal. Contacts are provided for switching the lights in on the exhibition of any signal and for switching the lights out when conditions are again normal. All circuits are normally de-energised.

It should be explained that the discs lie side by side, with the red one nearer to the front of the case and not as shown in the illustration. They have been drawn as shown in Fig. 3 so as to be better understood.

The operations are as follows:—An eastbound car, say, arrives in the loop A. If the driver sees the red disc in S A he knows that a westbound car is approaching him. If, however, it is neutral, he allows his train to advance and to make contact with the "on" contact A1. That transmits a current to the polarised relay R B and causes the red disc there to rise and to be held by the lock III. The current now goes to S A and raises the white disc there. When the train arrives at B and passes the "off" contact B2, the relay R B breaks contact at X and causes magnet I

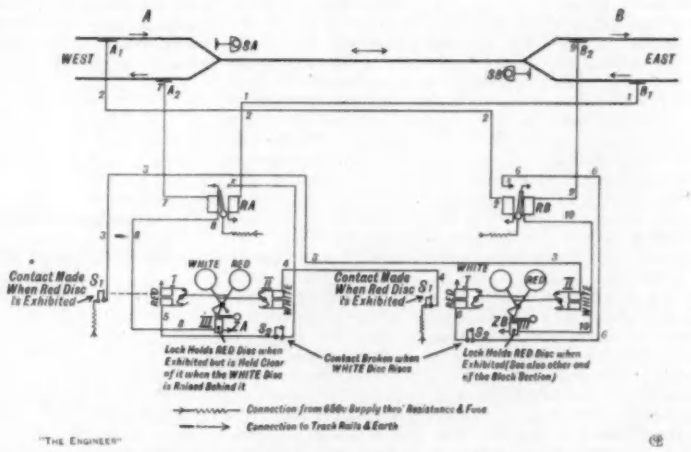

A
B
WEST
EAST
SA
SB
RA
RB
WHITE
RED
Contact Made When Red Disc is Exhibited
Lock Holds RED Disc when Exhibited but is Held Clear of it when the WHITE Disc is Raised Behind it
Contact Broken when WHITE Disc Rises
Lock Holds RED Disc when Exhibited (but also other end of the Block Section)
Connection from 650v Supply thro' Resistance & Fuse
Connection to Track Rails & Earth
"The Engineer"

Fig. 3—Connections for Electric Signalling

in R B to be de-energised. Simultaneously the lock III is released and the red disc falls because R B is de-energised. That opens contact S1 at B and the magnet II in S A is de-energised, so that the white disc there falls also. Both signals are now once more neutral. It will be understood from this description that the red disc must be exhibited at the further end before the white disc appears at the near.

There is a possibility of opposing trains arriving at their respective "on" contacts at the same time and for red to be exhibited in both signals, and as the appearance of red in one signal leads to white being exhibited in the opposing signal both white discs would follow. The drivers could not, however, act on that, as the white disc is behind the red and, therefore, is not visible. Then there

is lock III, which is holding the red in position, although the red Z magnets are now de-energised since the white discs are also raised. That arrangement has, however, as noted in the connections for signal S A in Fig. 3, been modified in that signal, and in all eastbound signals, and the white disc, when it rises, moves the lock clear of the red disc in that signal so that it falls. When that happens the magnet II in S B is de-energised and the white disc in S B also falls behind the red. The only indications then remaining are the red in S B and the white in S A, and the eastbound train thus gets the preference.

As it is a requirement of the Ministry of Transport that points, over which passenger trains run, when regularly used in a facing direction, shall be bolted to prevent them being moved under the train, such facing point locks had to be provided to all the loop points. Two difficulties then arose; one was that the points are spring worked and are forced open when used in a trailing direction, and the other was that there is no staff to actuate the points. Both difficulties were overcome by the Sykes Company making the lock normally "in" so that it was bolted when used in a facing direction. When used in the trailing direction the bar seen in Figs. 1 and 2 is depressed by the train and causes the withdrawal of the bolt before the switches are reached. The points are thus free to be forced open, and when the bar rises again the bolt again locks the points as soon as they spring back to normal.

In order that motormen when approaching the loop points in a facing direction may know that the points are in their correct position the lower signal seen in the photographic reproductions is provided. If the points are correct that signal shows a green light; if they are out of position a red light is exhibited.

Mineral Wool.

SOME interesting information regarding mineral wool, a material used extensively for insulating and other purposes, has recently been published by the United States Bureau of Mines, which has been conducting a study of the subject. Mineral wool, it is explained, is of two classes: (*a*) rock wool, which is made from a natural siliceous limestone, or calcareous shale, found in Northern Indiana or from an artificial mixture of silica and limestone; and (*b*) slag wool, which is made from iron blast-furnace slag with or without the addition of limestone to temper the charge.

Mineral wool is a substance composed of very fine, interlaced threads chiefly of calcium silicate and other glass-like materials similar in appearance to wool or cotton. Because of the high percentage of air space for a given volume of mineral wool, it is used mainly for insulating purposes. The material finds a considerable market for use in high-temperature insulation as a cover for pipe, annealing and baking ovens, and metallurgical and chemical furnaces, and in low-temperature insulation as stove and fireless cooker linings. Treated in a different manner it makes an efficient insulator for such uses as filling for house walls and floors, refrigerator lining, and covering for house and underground pipe lines. Used in interior walls and like places, it is an efficient sound deadener as well. Because of its acid-proof properties, it is also used as packing for acid carboys and as a filter medium for acids and corrosive liquids and gases.

The natural Indiana wool rock is mined from open quarries. For the manufacture of slag wool, the slag is loaded from the dumps at iron blast-furnaces, and transported to the manufacturing plant, which may be several miles distant. Both rock and slag are melted in cupolas very much in the same way as is cast iron. Coke is the usual fuel employed for this melting process. The molten material issues from the bottom of the cupolas in a small stream. The slag, as it falls, is broken up by a steam jet into minute balls or shot, which, while still in a molten condition, are propelled rapidly through the air. In passing comet-wise through the air fine threads of glass-like material form as tails to the shot and fall in a fluffy mass on the floor of the wool room. The wool blown into the wool rooms is gathered either by hand or on conveyor belts for further processing.

Loose wool is the sole product of several plants and finds a ready market wherever a loose insulating material is required. Mineral wool is also used in loose form as a filter medium for acids and corrosive gases, as well as for packing around acid carboys for shipment. Loose wool is run through machines termed "granulators," the function of which is to break the shot from the fine threads and remove it. This treatment results in a short-fibre, shot-free wool which is used for mixing with other materials in the manufacture of insulating cements. This material is also used extensively as house insulation. The granulated wool is blown by low air pressure into the spaces between the studding and joists of buildings already constructed and forms a very effective heat and sound insulator.

In addition to this method of using granulated wool for house insulation, raw wool is placed between wire netting, such as window screening, chicken wire, or chicken wire and metal lath. These "blankets" are made in various sizes and thicknesses to suit consumers and for house insulation are placed directly on the studdings or between them. Where metal lath is used on one side, the lath is plastered in the usual manner. Similar products are made for refrigerator and cold room linings. Blankets are also used for boiler and oven coverings, and are in turn covered by insulating cement. Covering for outdoor tanks in which liquids must be kept above freezing is a similar use for this class of fabrication. Used in blankets or as loose wool, the material is said to be of great benefit in controlling the acoustic properties of buildings, and in rendering noiseless small machinery units, such as house refrigerator motors, &c.

Probably the greatest use for raw and granulated wool is in the manufacture of "rock cork" or "rock felt." Blocks of this material are made in various sizes and thicknesses for refrigerator lining. Raw or granulated wool, together with other ingredients and various binders, is mixed with water into a stiff mud and is placed on pallets and subjected to low pressure. These pallets are then run on racks into drying rooms and dried in a current of hot air. This material is also moulded into forms for pipe covering and is covered with cotton. Often it is reinforced with chicken wire. High-temperature insulation is made from a mixture of refractory binders with the wool; the whole mixture is compressed into blocks or brick. Such material is used for covering glass and metallurgical furnaces, annealing and enamelling ovens, and for pipe covering.

SIXTY YEARS AGO.

THE first leading article in our issue of August 13th, 1869, was devoted to an appreciation of the annual meeting of the Institution of Mechanical Engineers, which had just been concluded at Newcastle-upon-Tyne. Visits had been paid to the new high level and new low level Tyne bridges, then in course of construction, and also to Elswick works and the ironworks and shipyards of Palmers' Shipbuilding Company, in addition to chemical works. We commented on the astonishing combination of immense and successful industries which were to be viewed in the Tyne and Wear areas, and the wide range of interest these afforded to engineers. At Palmers' Yard two large British warships of the Reed central battery type were then at the stage at which the 3½in. hard wood covering was being applied to the whole of hull before the copper or yellow metal sheathing was put on. The stems and stern frames of the ships were fine bronze castings, and the cost of over 80 tons of bronze for the frames of each of these vessels led us to turn to Sir William Armstrong's presidential address, and to reflect on the costly nature of war material and the probable effect of this high cost upon remotely future wars. Sir William said that the effect of mechanical invention was to discourage aggression and thus to maintain peace. He anticipated the present movement in the direction of disarmament, by expressing the hope that the further development of mechanical science would hasten the arrival of a period when civilised nations would abandon the abitrament of arms and settle their differences by rational and peaceful methods. In the earlier part of his address, Sir William Armstrong dealt with a subject very much his own, namely, that of steel and the stresses it would bear. He held that although steel had a much greater tensile strength than wrought iron, it was nevertheless less adapted to resist concussive strain. Vibratory action, he went on to say, was more dangerous to steel than to iron, and want of uniformity was another serious objection to its use. We counselled engineers to be very careful in their use of steel, which possessed, we said, some peculiar quality inherent in its nature which conferred upon it the power of leading the most wary astray. That opinion was expressed in a second leading article in which several instances of failures leading both to mechanical and legal truths were cited. In the same issue we described and illustrated a novel type of vertical marine water-tube boiler for small yachts which had been patented by Mr. T. Messenger. The water-tubes were placed in an outwardly inclined circle round the fire-box, and there was a spiral copper coil in the uptake which served as a feed-water heater. The boiler worked at a designed pressure of 50 lb. per square inch.

B.E.S.A. SPECIFICATIONS.

THE PERFORMANCE OF CEILING TYPE ELECTRIC FANS (No. 367–1929).

THE above new British Standard has just been issued. Its object is to define certain features of propeller type ceiling fans which relate to their performances, and to regulate the method of testing ceiling fans so that the results of the tests may be reasonably comparable. The type of fan covered by the specification is designed to rotate in free air, and to produce disturbance of the air in the room in which it is made to operate. It is obvious that to obtain a determination of the true air movement in a room with a fan under working conditions would be extremely difficult and costly, since a large number of points would need to be examined, using instruments of high sensitivity and precision. In order to simplify the test, therefore, and make it suitable for commercial use, the specification provides a test which, whilst not strictly complying with the working conditions of the fan, is such that the effectiveness of the fan is in no way impaired. In the introduction to the specification, which was drawn up after a large amount of research had been carried out, it is explained that in preliminary tests in which the fan was suspended at the centre of a four-sided screen, it was found that the type of air flow is characteristic and consists of a central stream of relatively high-speed air, covering an area only slightly larger than the sweep of the fan blades, and a surrounding stream of air which is moving relatively slowly downwards. An analysis of the test results has shown that practically all the variation takes place in this outer or induced stream and that the volume of air being removed directly by the fan blades is practically constant. It therefore appeared that uniform results could only be obtained if the test were confined to the central air stream. Consequently, for the purpose of this specification, the measurements are confined to this central stream. The specification suggests that a statement of the air delivery per watt of input is a better indication of the service value of this type of fan than a determination of the overall mechanical efficiency, *i.e.*, the ratio of the actual power output to the power input.

Copies of this Specification, No. 367–1929, may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. post free.

THE Southern Railway obtains all its ballast for the Western division, as well as a goodly portion for the Eastern division—the former South-Eastern and Chatham—from its Meldon quarries, near Okehampton. An additional stone-crushing plant has now been installed there, and the output raised from 110,000 to 150,000 tons per annum.

THE CHADWICK TRAVELLING SCHOLARSHIPS AND THE BOSSOM GIFT SCHOLARSHIP.

IN view of the quality and number of the applications received for the two Chadwick Travelling Scholarships in Sanitary Science and Municipal Engineering, advertised in January last for award in July, the Trustees decided to make three instead of two appointments. The successful candidates were:—

Edmund A. Elsby, B.Sc., and Honours Chemistry, Liverpool University, a Technical Chemist and Chemical Engineer, who is appointed to study and collect data in this country and America respecting the removal of silica dust from atmosphere in factories and other places where grinding operations are carried on; and

John B. Dempster, B.Sc., in Civil Engineering, Glasgow University and Testamur of the Institution of Municipal and County Engineers. This scholar is to study sewage and sewerage with special regard to trade waste, alone and with crude sewage. His itinerary will take him to the larger towns of the Rhine Valley from the Dutch border to Basle.

The other successful candidate has to carry out a medical research.

All these scholarships are tenable for one year, and are of the value of £400 each.

Another scholarship within the appointment of the Chadwick Trustees is the Bossom Gift Scholarship, to enable the holder to make a specialised study and present a scheme showing the most complete and efficient system of heating and ventilation adaptable to a hall seating about 1000 people, with smaller rooms attached and a set of residential quarters in the same building. The value of this gift is £100, and the proposed specialised study is to include, if practicable, a journey abroad. As for the Chadwich Travelling Scholarships, candidates for the Bossom Gift Scholarship must be British subjects. Young engineers or architects, or students who can produce evidence of attainments indicating a capability of designing such a scheme, are invited to compete, and applications should be sent between August 26th and September 30th to the clerk of the Chadwick Trustees, at 204, Abbey House, Westminster, stating name, qualifications, age and proposed itinerary study or research. Testimonials and evidence of previous work undertaken or published should be submitted with the applications.

THE IRON AND STEEL INSTITUTE.

THE following is the list of papers which it is expected will be submitted to the Autumn Meeting of the Iron and Steel Institute, which is to be held at Newcastle on September 10th, 11th, and 12th next:—

(1) A. T. Adam, "Notes on Wire for Mining Ropes."
(2) H. A. Dickie, "The Solubility of Carbide in Ferrite."
(3) E. Diepschlag and F. Wulfestieg, "Electrical Conductivity of Magnesite and Some Other Refractory Materials in Relation to the Temperature and their Other Properties."
(4) C. S. Gill, "Notes on the Damping-down and Re-starting of Blast-furnaces."
(5) E. G. Herbert, "The Hardening of Superhardened Steel by Magnetism: The Lattice Resonance Hypothesis."
(6) A. Hultgren, "Crystallisation and Segregation Phenomena in 1·10 per cent. Carbon Steel Ingots of Smaller Sizes."
(7) J. A. Jones, "High Elastic Limit Structural Steels."
(8) H. O'Neill, "The Hardness of Vacuum-annealed Crystals of Iron."
(9) T. A. Rickard, "Iron in Antiquity."
(10) J. H. Smith, C. A. Connor, and F. H. Armstrong, "The Correlation of Fatigue and Overstress."
(11) J. H. Whiteley, "The Coalescence of Pearlite."
(12) T. D. Yensen, "Iron-Silicon-Carbon Alloys: Constitutional Diagrams and Magnetic Properties."

It is expected that these papers will be read in the following order:—First day, Tuesday, September 10th, Nos. 4, 1, 6, 7; second day, Wednesday, September 11th, Nos. 11, 2, 12, 9; and third day, Thursday, September 12th, Nos. 5, 3, 8, 10.

REGIONAL PLANNING FOR NEW YORK.

A REGIONAL plan for the New York metropolitan area of 1965, with roads, main line and suburban railways, tramways, air ports and other facilities, has been completed and presented by a commission which has been studying the subject for seven years. The region considered has an area of 5528 square miles, with 436 cities and towns, and a population estimated at 20,000,000 for 1965. Of the present 10,000,000 population about 6,000,000 live in the city of New York, on an area of 298 square miles. That city has 9000 miles of streets. Within the entire region there are about 421,000 passenger automobiles, 107,000 motor trucks and 34,000 motor omnibuses and taxicabs. It has 690 miles of rapid-transit lines and tramways, which in 1928 carried 3500 million passengers. There are twelve main line railways with 1900 miles of line, carrying about 250,000,000 passengers yearly, of whom 75 per cent. are regular suburban passengers. For air transport there are already thirty air ports. Population density varies from 104,000 per acre in the Manhattan district or main portion of New York City, to 45 per acre in the outlying country districts. But the entire area is such that its population can and does travel between home and work in reasonable time, and is, in fact, a suburban area. One purpose of the scheme is to lessen the density of congested centres and to establish new centres for business, industry and residence. The plan provides, therefore, for a comprehensive system of radial, belt and connecting roads and boulevards, electric rapid transit lines, railway extensions, connections, termini and loop lines, and about forty air ports and seaplane landings.

Accelerator for Hot Water Heating Systems.

A MINIATURE accelerator for small low-pressure hot-water heating systems, such as are used in country houses or in horticultural hot houses, has recently been introduced by Holden and Brooke, Ltd., of West Gorton, Manchester. It is illustrated in the accompanying engravings. The application of this appliance, called the "Selfix minor," to heating systems is claimed to overcome the difficulties experienced when the circulation of the water depends on gravity flow which, in turn, is dependent on the resistance set up in the pipes by radiators, valves, bends, &c.

The flow of the water is effected by means of a small

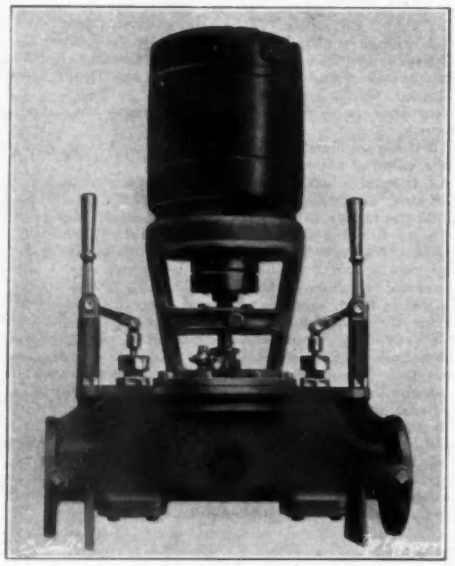


FIG. 1—ACCELERATOR FOR HOT WATER SYSTEMS

centrifugal impeller A—Fig. 2—which is contained in a cast iron bed-plate B. This bed-plate also contains a pair of isolating valves C D, which are operated by hand levers E F. The valve D also serves as a non-return valve. The impeller is mounted on a vertical spindle which is supported by a double-purpose ball bearing to take up the thrust of the impeller and the weight of the rotating parts, while an additional location bearing G is provided in the bed-plate. The impeller is driven by means of a vertical ½ horse-power electric motor mounted on a cast iron skirt attached to the bed-plate by studs. The weight of the motor armature is taken by its own bearings, and the transmission of heat from the pump shaft to the motor is prevented by a flexible coupling in halves which has

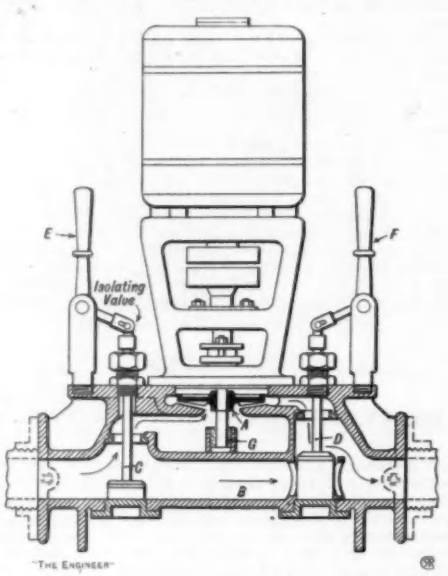


FIG. 2—ARRANGEMENT OF ACCELERATOR

driving pins covered with a resilient heat-non-conducting material.

This set is designed for 2in. pipes, and the capacity is 5 gallons per minute against a frictional head of 9ft. to 10ft. The set is constructed throughout of cast iron with the exception of the isolating valves, valve levers and the pump impeller, all of which are of phosphor bronze. The power absorbed is 0·3 B.H.P., which is well within the capacity of the power supply for a domestic electric fire.

THE French liner *Ile de France*, which is at present on a voyage from Havre to New York, is carrying an aeroplane for ship-to-shore mail service. It is intended that the machine shall be launched from the vessel in time to allow of letters being delivered twenty-four hours before they could reach their destination if carried all the way on the liner. On the return trip the aeroplane will alight on the Seine in the neighbourhood of Paris.

"Air Rights."

WE reprint the following article from the issue for July 31st last of our Canadian contemporary, *Contract Record and Engineering Review*. The point discussed is of considerable interest.

The sale or lease of air rights, in other words, the sale or lease of the space above real estate, is a development that has lately taken on important significance. So far transactions of this kind have been few in number, but they indicate a trend that is likely to extend to many cities of the continent and to lead to the erection of important and costly buildings on sites that up to now have been considered closed to building operations.

To understand the possibility of air right development consider the water front railway situation in Toronto, for example. In that city a vast area of downtown property—property of the most desirable character from a building standpoint—is given over to railway trackage, and has never been considered available for the erection of commercial structures. In view of recent developments in Chicago and New York City, however, this situation need exist no longer, for if the railways so desired they could dispose of the space, or air rights, above their real estate holdings, retaining only such space above the ground as is necessary for the operation of trains.

The principle can apply just as well to other types of real estate—not necessarily railway holdings. For example, an owner of property on which is to be erected a building of limited height but quite adequate for his needs—perhaps one, two or three storeys—might dispose of the space above his proposed building and thus permit the joint erection of a high structure in which he will own in fee simple the bottom part and the owner of the air rights will own the upper part, also in fee simple.

One of the best explanations of the development of air rights and of the problems involved in them has been provided by Laird Bell, counsel for the *Chicago Daily News*, whose new twenty-six-storey office building covering a ground area of 106,000 square feet was completed only this summer on an "air lot" over property belonging to the Chicago Union Station Company—the first building, as far as we know, that has yet been promoted through the acquisition of air rights. Several others, in Chicago and elsewhere, are now either in course of construction or contemplated. Mr. Bell thus explains the problem :—

THE LEGAL ASPECTS.

Subdividing the air horizontally is a legal device of recent origin. A maxim has come down from the days before Blackstone, which, after removal of the Latin, reads that "he who owns the ground owns up to heaven." Thus far the law has not found it necessary to define that upper limit with any exactitude. But a sort of economic vacuum has long existed over railroads in big cities. Recently great buildings have been crowded into this space, and in consequence questions of law relating to the space have acquired new significance.

The initial question is whether an abstract thing like space can be bought and sold as land. The air, as such, obviously cannot. The rules of real estate law are, above all others, founded on historical bases. Many things that now appear to be simple vagaries are the lineal descendants of early English customs. Before the days when many people could sign deeds, real estate was transferred by the owner's going upon it and handing to the purchaser a clod of earth. That was called livery of seizin. We still keep the word seizin and many of the formalities that went with those early customs. Therefore, the lawyer passing upon the validity of the creaton or transfer of air rights is confronted by the question whether the historical limitations on dealing in real property are likely to trip him up.

SALE OF SPACE VALID.

Digging about in the precedents has disclosed a surprisingly large number of cases in which courts of last resort have treated as valid the sale of space. The first case in Illinois arose during the Civil War. A case arose in Ohio as early as 1832 and numerous others are found scattered through the reports of the various States up to recent years. Most of these cases arose through the sale of the top storeys of buildings. One may infer from the litigious character of the cases—in two instances the same controversy reached the State Supreme Court twice—that such a division of property does not tend to neighbourliness. Omitting the social aspects of the situation, however, the cases seem to establish clearly that the sale of such space is valid.

Separate ownership of rooms and storeys has been much more common in England than in America. The chambers of the barristers in the Inns of Court in London are bought and sold apparently on a fee simple basis. Evidently the solicitors and barristers have found no difficulty in the situation, for no cases involving such transfers have been found in courts of record. Perhaps on the principle of the cobbler's children going without shoes, the gentlemen of the bar have foregone the pleasure of personal litigation.

LEGISLATURE SANCTIONS AIR RIGHTS.

The net result of the precedents seems clearly to be that there is neither a policy of law against horizontal subdivision above the ground nor any historical precedent which would militate against it. So far as Illinois is concerned this has been clinched, as to railroad property at least, by a law passed at the 1927 session of the Legislature specifically authorising railroads and terminal companies to subdivide the separate levels and sell or lease them, provided that the action does not unreasonably impair the use of the real estate for railroad purposes.

Where the air rights are over railroads, however, additional problems arise. There is first the question whether the railroad owns an outright title or whether it acquired, by condemnation, merely the right to use the land for railroad purposes. In the latter case the sale or lease of air rights is not possible, except by joint action between the railroad and the heirs of the person who owned the land when it was condemned.

The second difficulty arises from the existence of general railroad mortgages. No one cares to put up a large building that, even on a remote chance, may be taken away through foreclosure of a railroad mortgage. Most railroad mortgages, however, permit the release from the mortgage of any property except lines of main track and right of way.

HOW THE SALE WAS ACCOMPLISHED.

The problem then is to sell the air rights free of the mortgage without affecting the lines of track and rights of way. The solution finally reached in the case of the *Daily News* was simple. It was worked out by counsel for the *Daily News* with Frank J. Loesch for the Union Station Company. The Union Station Company deeded to the *Daily News* the entire interest in the block where the building stands, but excepted from the conveyance the space below the level of the floors over the tracks and simply gave the *Daily News* the right to run columns and foundations through the excepted space at points not interfering with the tracks. The trustee of the general mortgage of the station company then released the same property, without interfering with the right of way.

The deed includes a number of detailed covenants as to indemnity for injury to the railroad property, against overloading, requiring facilities for smoke exhaustion, &c. The whole is comprised in ten printed pages.

THE MERCHANDISE MART PLAN.

The only other outright sale of air rights over railroads in Chicago was the sale by the Chicago and North-Western Railroad Company to Marshall Field and Co. of the space over the old North-Western terminal. In this case a radically different type of conveyance is used. With great ingenuity, a three-dimensional subdivision has been worked out. The scheme consists of one lot called an air lot, which is all the space within the ground lot lines above a specified plane. There are then some three hundred lots, cylindrical in shape, extending from the air lot down into the ground, "all the way down." The remainder of the property, being all the property below the plane and not included in the cylinders, is another lot and is reserved to the railroad. The sale is of the air lot and the cylindrical lots. The lots are centred on range lines with known bases and have all the particularity of description required by law for a plat. The plat is recorded just like any other subdivision plat. The scheme has the virtue of great definiteness. It has the disadvantage of rigidity.

The flexibility of the Union Station-*Daily News* scheme is obvious. Whenever it may be desired to make a change in the layout the right to an easement of support will follow the column. When it comes to rebuilding, a radical rearrangement can readily be made. Foundations of to-day are very different from the foundations of fifty years ago. The future may develop new and better types of support. The conveyance of the air lot with the right somehow or other to support the buildings is easily adaptable to the mysteries of the future.

NEW YORK AND PHILADELPHIA TRANSACTIONS.

Conveyances similar in principle have been made in New York and Philadelphia over railroad property. None of the known instances has lasted through any great number of years or faced any great change in either the physical or the economic aspects of building. No legal difficulties developed in these cases, and none whatever was encountered during the erection of the *Daily News* building. Presumably, however, as time goes on, such difficulties will develop and be guarded against in subsequent conveyancing, just as in the case of the impressive tomes which corporate mortgages and ninety-nine-year leases have grown into. In the course of a few years the present document may have all the charm of the primitive. It has, however, so far met the acid test, in that it has worked.

MANY ADVANTAGES IN AIR RIGHTS.

One important feature of air rights which will facilitate their development because of the larger spaces available, is the fact that prospective builders will have the distinct advantage of dealing with a single owner, rather than undergoing the interminable toil of acquiring small sections to make a site large enough for buildings of the modern type. Those who have been through the mill trying to acquire and assemble small parcels of land in a highly developed metropolitan district will appreciate the importance of this factor.

South African Engineering Notes.

Germiston Sewerage.

THE town of Germiston on the Witwatersrand is raising a loan in which provision is made for a big sewerage scheme, involving a capital cost of £331,000. The annual working cost of the scheme is estimated at £24,000, inclusive of loan charges. Services to isolated areas and underground mine services will bring the total annual working cost to £29,464. The present annual working cost of the smaller sanitation service is about £25,000.

Manganese.

Now that it is being realised in Europe and the United States that the Union of South Africa has huge quantities of high-grade manganese, a great desire to obtain possession of some of the properties is being manifested. Negotiations are now proceeding which are likely to result in a London financial house acquiring the properties of the Gamagara Manganese Corporation (Postmasburg), Ltd., and the Postmas Manganese Fields, Ltd. The first company holds the farms Klipfontein and Sisten and 1000 acres of Postmasburg commonage lands. High-grade manganese ore has been opened up on Kl pfontein, and the area is favourably situated for cheap and rapid mining operations. The area held by the second company includes four farms with a total area of 8236 morgen—a morgen is 2·23 acres. A large amount of prospecting work has been done, proving the existence of a considerable deposit of manganese ore assaying up to 54·61 per cent. These companies are entitled, as are all manganese producers in that area, to have their product carried by the new railway being built for the Manganese Corporation,

but will, of course, be required to contribute a proportionate share of the cost of the railway.

Most of the manganese deposits of the world are mined—that is, the ore is extracted through underground workings. The mining costs vary from 5s. to 20s. per ton. Practically all the deposits are distant from the coast, necessitating railway haulages, costing as much as 25s. per ton. Ocean freights vary, of course, but if the ore has to go through the Suez Canal there is a surcharge of approximately 5s. per ton, and an average rate of 20s. per ton may be assumed for ocean freight. Manganese mining in the Postmasburg district is an ordinary quarrying operation, and the cost, including crushing and loading into trucks, is estimated at 2s. 6d. per ton. The S.A. Railways have quoted a rate of 16s. per ton to ship's hold, Durban, from Postmasburg. The ore does not go through the Suez, so there is a saving of at least 5s. per ton on ocean freight, and the manganese can, it is stated, be landed in Europe or America at a much lower price than other competitive manganese. The S.A. Railways have placed at the disposal of the Manganese Corporation a new and up-to-date wharf at Durban where facilities for loading 2500 tons of manganese per day will soon be available. They have also provided free storage space for 10,000 tons of ore at Durban and are giving facilities for the storage of a further 5000 tons at a small cost. On account of the peculiar position of the manganese deposits, relative to the steel-producing companies, it is estimated that an average profit of £1 will be obtained on every ton of manganese ore shipped. The Manganese Corporation proposes, by itself, to ship at least 350,000 tons of the ore from the Union each year.

Steel Bounty to be Paid.

The Minister of Mines and Industries—Mr. F. W. Beyers—has decided to pay, under the Steel Bounties Act, the bounty claimed by the Union Steel Corporation in respect of the blast-furnace at Newcastle, Natal. This bounty, which amounts to approximately £40 000, was refused by Mr. Beyers last year. The bounty of 15s. per ton is payable by the Government only if the Minister is satisfied of the productive capacity of pig iron possessed by the works, and upon this point he was not at that time satisfied. On the refusal of the Minister the Union Steel Corporation sued the Government and won, but the decision was reversed on appeal. Nothing daunted, however, the Union Steel Corporation restarted its blast-furnace and produced 28,000 tons in six months, the capacity fixed by the Government being 50,000 tons per annum. The Government's advisers proceeded to Newcastle, and made an exhaustive investigation, as a result of which the Government has decided to pay the bounty, as the factory is considered to have met all requirements.

S.A.R. Road Motor Services.

The open mileage of road motor services operated by the S.A. Railways has passed the 10,000 mark. In the first fortnight of May, eight new routes, representing 253 miles, were started, the principal ones being Smithfield–Dewetsdorp, 54 miles; Marquassi–Tweelingpan, 54 miles; Marquassi–Rustkraal, 41 miles; and Wolmaransstad–Doornpan, 33 miles. At May 21st last, the total open mileage over which the Administration's road motors were operating was 10,004. In addition, 1839 miles had been authorised.

Extracting Gold from Reef.

Mr. George Paul Davidson, a well-known Johannesburg metallurgist, who has been studying the problem of extracting the very refractory and finely distributed particles of precious metals known to exist in the black reef, which have hitherto eluded all efforts to recover them, now claims to have discovered a successful solution by a chemico-electrolytic process, which arrests even the most microscopic particles at a comparatively low cost. He asserts that this process will revolutionise Rand mining, as it may supersede the costly cyanide process and obviate the necessity for preliminary concentration. Crude bullion obtained by this method and sent to the Standard Bank for assay shows, it is stated, 7·301 oz. of gold and 227 oz. of platinoid per ton of bullion. Better results are expected from a commercial-scale plant now in course of erection a few miles from Johannesburg.

New Platinum Producer.

Arrangements were made for the official starting up of the Waterval (Rustenburg) Platinum Mining Company's reduction plant on July 23rd. The Waterval Company is the second subsidiary of Lydenburg Platinum, Ltd., and is the first of the Rustenburg platinum concerns to reach the production stage. The company's property—Waterval 537—lies 2 miles north-east of the town of Rustenburg, and the Pretoria–Rustenburg railway runs right through the farm. The consulting engineer states that the property is highly valuable. The conspicuous regularity of the values in the main section, and, further, the notable gradual increase of values in depth permit the conclusion that, wherever the reef is tested under normal conditions, the values are good and disturbances and abnormal conditions are scarce on Waterval, and seem to be confined almost entirely to the west section, and to become less pronounced in depth. Six boreholes were put down, and of them only one failed to produce a full reef core. This borehole is well within the most regular zone, and gave, in spite of the loss of the last 2in. of reef, 4·85 dwt. The company has been financed by, and is under the control of, the New Consolidated Gold Fields. A process has been developed for the successful extraction of the platinum metals from oxidised and semi-oxidised ores, and a plant capable of treating 10,000 tons a month has been erected. The size of the plant marks a great advance on the plants now operating on other platinum properties in the Union, none of which mill tonnages averaging 3000 tons per month. The proposed output should yield, with an extraction of 85 per cent., 2000 oz. of platinum group metals per month, representing, at present prices, about £27,000. As the great thickness of ore will render mining easy there should be a good profit, and the end of the year should see South Africa producing a substantial quantity of platinum.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Business Resumed.

WORK has now been generally recommenced in the iron and steel and engineering works of the Midlands and Staffordshire and gives promise of continuing steadily until the autumn demand develops. Most works are well placed for the time of the year, and the trade outlook is moderately good. The past week has brought a fair number of inquiries in all branches of the material market, but actual transactions have been on the small side. Specifications for delivery of iron and steel are well maintained, however, and producers express no concern regarding the disposal of their output. Small scale and irregular buying is commonly looked for at this season, and a spell of market quietude is anticipated. Engineering firms and manufacturers in this district do not, on the whole, complain of the business done so far this year, though many admit that it has not come up to expectations. Present indications suggest that the remainder of the year will provide, at least, normal business. Much, of course, depends upon industrial peace, and upon the Government's action regarding Safeguarding and the McKenna Duties. The prospective schemes of work for the absorption of unemployed are looked to to provide general engineers, tool makers, and others in this area with additional business. The heavy engineering trade hereabouts is rather better situated than at this time last year, and it is hoped progress will be maintained.

Nuneaton Factory Reopened.

Work was resumed on Monday at Messrs. Courtauld's processing factory at Nuneaton, which had been closed down since August 1st, as reported in my letter last week, for an extended holiday, owing to the cotton dispute. Full time, however, cannot be put in and it has been arranged that one half of the operatives shall work one week and the other half the following week until the situation justifies full time operation or necessitates further restriction of output. The Wolverhampton factory is in operation, but the time worked has been reduced.

Orders for Midland Firms.

Some large new orders have recently been placed with Midland rolling stock firms, which will entail the consumption of considerable tonnages of steel. The orders, on the receipt of which local industrialists offer congratulations to the firms concerned, include 400 12-ton covered goods wagons for the London, Midland and Scottish Railway Company, awarded to the Metropolitan-Cammell Carriage, Wagon and Finance Company, Birmingham; 300 12-ton covered goods wagons for the L.M.S. Railway to the Gloucester Railway Carriage and Wagon Company; 178 steel-bodied bogie vehicles for the Central Argentine Railway to the Birmingham Railway Carriage and Wagon Company; 91 steel-bodied bogie wagons to the Metropolitan-Cammell Company; and 16 dining cars to the Gloucester Railway Carriage and Wagon Company. For the Rhodesian Railways the Metropolitan-Cammell Company is to make 200 high-sided all-steel wagons, and the Birmingham Railway Carriage and Wagon Company 100 drop-sided wagons, while the Gloucester Railway Carriage and Wagon Company is to provide the Nigerian railways with three all-steel passenger coaches. An order for the complete equipment of a new switch house at the power station of the Croydon Corporation has been placed with the English Electric Company, of Stafford. The order is of the value of £44,300.

Raw Iron Prices.

Midland smelters came on to the market in Birmingham to-day—Thursday—ready to do business on the basis of the Association minimum selling prices, and though consumers endeavoured to get concessions smelters would not hear of transactions which did not come up to the recognised level. They are fortunately placed for business, and while new orders are not over numerous, order books are well filled and specifications against contracts flow freely. With production costs higher than when the latest selling figures were arrived at, they see no cause for jeopardising their chances of profitable production by accepting lower prices. With one accord they quote Northamptonshire forge £3 8s. 6d.; No. 3 foundry, £3 12s. 6d.; Derbyshire forge, £3 12s.; and No. 3 foundry, £3 16s., for delivery to stations in the Black Country area. Blast-furnace coke remains scarce and dear, ovenmen this week quoting 16s. 6d. per ton at ovens for coke suitable for use in Midland furnaces. This fact helped to strengthen the position of furnacemen and users of pig iron bought the small tonnages they required for current consumption at smelters' figures. No more iron than is absolutely necessary is, however, being purchased just now.

Finished Iron.

The holiday break in the Staffordshire iron trade has not materially changed the general trading position. It had been hoped that some small accumulation of orders, especially in the Crown bar department, would have taken place, but this has not generally proved to be the case, though in a number of cases orders were added to firms books, which made the running of mills during the remainder of the month more secure. Ironmasters are becoming concerned at the continued rise in raw iron and fuel costs, and an increase in selling prices of finished iron would hardly come as a surprise to the market. It is understood that ironmasters are anxious to keep the level of selling prices down in order to encourage business, but buyers foresee the probability of a forced rise in finished iron prices. At date Staffordshire marked bars are £12 per ton, Crown bars £10 to £10 5s., and nut and bolt and fencing bars £9 upwards. Makers of Crown bars have to contend with competition from makers in other districts, who offer supplies at as low as £9 12s. 6d. Producers of common bars have to compete against Belgian makers, who will deliver No. 3 iron to the Black Country bolt and nut works at less than £7 per ton. The amount of business available in this department is not very large, and the bulk of it goes to sellers of foreign material. Demand for wrought iron tube strip is well maintained, and this material is selling at from £11 to £11 2s. 6d. per ton.

Galvanised Sheets.

Galvanised sheets are still quiet, 24 gauge corrugateds making £13 7s. 6d. per ton. This is a low figure, and any revival of export buying would, it is considered, be almost immediately followed by an increase in sheet prices.

Firm Steel Values.

The steel market is moderately brisk, and values are firmly held. The call for joists, sections and plates has improved slightly, and steady progress in the structural engineering branch is looked to to provide some useful orders. Makers of railway rolling stock should prove good customers in the coming months. Makers of alloy steels have been receiving some useful orders from motor car manufacturers and producers of component parts. Demand here has fallen away temporarily, due to seasonal influences. The foreigners, efforts to secure business in the small bar and strip departments of the steel trade have met with some success, but steelmasters hold on to late selling prices. Whereas the foreigner offers small steel bars at as low as £6 16s. 6d. delivered, most local re-rollers ask £8 5s. Continental steel strip can be had at £7 12s. 6d. upwards, but native material costs about £8 7s. 6d. Despite the wide disparity in price, quite a lot of native material is being purchased. Merchants have recently been cutting prices of foreign material, and it would not occasion surprise if selling values of foreign material showed some advance in the near future. Billet makers are not so well placed for business as of late, owing to the lessened activity in the tinplate and galvanised sheet trades. English billets are quoted £6 10s. to £6 12s. 6d., and sheet bars £6 7s. 6d. upwards. Welsh billets are £6 7s. 6d., and continental 2in. billets make about £6 delivered.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Industrial Conditions.

CONDITIONS in the engineering trades are reviewed as follows by the Manchester Chamber of Commerce in the course of its monthly survey of the general trade situation in this area:—The improvement in the engineering trades previously noted has been maintained. There is more disposition to place orders for special machinery and machine tool makers have been more fully employed, some, indeed, being busy. Textile machinists are still largely dependent upon overseas orders, and these have been neither sufficiently numerous nor very remunerative. Locomotive builders have had a good many foreign and colonial contracts in hand, but home demand has not been brisk. Boiler-making continues very dull, but other branches of the industry have been fairly well engaged. The heavy electrical trades have been fairly active, and there will shortly be a good deal of work waiting to be done under the national electric power schemes. The motor car trade has been told officially in Parliament that it must not expect the McKenna Duties on imports to be continued in next year's Budget.

Additions to Work.

The electrification of the Manchester South Junction railway from Manchester (London-road Station) to Altrincham, now actively in progress, has been productive of a substantial contract for rolling stock, additional to those for electrical equipment referred to recently in this column. The railway group concerned has now placed an order for twenty-four motor cars, twenty-two non-driving trailer cars, and twenty-two driving trailer cars, of a total value of about £200,000, with the Metropolitan-Cammell Carriage and Wagon Company, Saltley, Birmingham. Orders for ten locomotives for the Rhodesian Railways and for three for the Peruvian Central Railway have been secured by Beyer, Peacock and Co., Manchester, and one for telephone cable for the Egyptian State Railways has been placed with British Insulated Cables, Ltd., Prescot. Henry Simon, Ltd., Manchester, has been the successful tenderer for mechanical coal-handling plant, to be constructed at the new Clarence Dock at Liverpool.

An Electricity Merger.

The Ormskirk electricity undertaking has, it is announced, been purchased by the Lancashire Electric Power and Lighting Company.

Textile Machinery Plant Closed Down.

The directors of Lord Brothers, Todmorden (Brooks and Doxey, Ltd.), have decided to transfer the manufacture of textile machinery now carried on at the Canal-street Works, Todmorden, to their Union Works, West Gorton, Manchester, about 250 employees being affected. The firm of Lord Brothers was established nearly 100 years ago, and the Canal-street Works were taken over by Messrs. Brooks and Doxey in 1920.

Money for Omnibuses.

Further opposition to the proposal of the Tramways Department to purchase motor omnibuses at a cost of £110,000 out of borrowed money was forthcoming at the last meeting of the Manchester City Council, but after some discussion the Tramways Committee's recommendation was approved. Not so, however, a proposal of the Committee that the tender of the Associated Equipment Company, Southall, Middlesex, for ten single-deck motor omnibuses and five chassis and engines be accepted. On the ground that Messrs. Crossley Brothers, Manchester, in connection with this contract had not been properly

treated, the Committee was urged to give the matter further consideration, and that the chairman, after some discussion, agreed to do.

Not Yet Settled.

The proposed appointment of a chief engineer by the Manchester Gas Committee was also referred back, this time on the motion of the Establishment Committee. Without again going into details, it may be recalled that originally the Committee advertised the appointment at a commencing salary of £1500, which figure was raised later to £2250, and then finally reduced to £1750. The Establishment Committee's action, it was explained at the meeting of the City Council, was due to the fact that the candidate recommended by the Gas Committee to fill the position—Mr. A. L. Holton, at present manager and engineer of the Bradford-road gasworks of the Manchester Corporation—had previously offered to perform the duties of chief engineer at a commencing salary of £1500.

Non-ferrous Metals.

Weakness of varying extent in tin, lead, and spelter, and further steadiness in the copper section—this, in brief, summarises the effect of the past week's events on the non-ferrous metals market. For the time being, at all events, a healthier tone is in evidence in the case of copper, the result, to some extent, of an improvement in conditions in the United States. This has served to continue the renewed steadiness which has characterised this section since about the second half of last month. Although much of it is of a speculative nature, buying interest in the metal has shown some expansion of late. Although the statistical outlook for tin is regarded, if anything, rather "bullishly," there has been rather a severe set-back in this section since last report. To some extent, probably, this is the result of a certain amount of realisation, another factor being a further increase in domestic stocks. Buyers, with the change in conditions after the recent steady rise, are disposed to take a cautious view of things, and business during the past week has only been moderate. Although there has been a fair amount of interest shown in lead, foreign advices have reacted on markets on this side, and prices have lost a portion of the previous week's advance. The comparatively slow movement of spelter into consumption continues to exercise a depressing influence on prices, bringing current values to a new low level for the present year.

Iron and Steel.

There has been no revival of buying interest in the foundry iron market locally so far, but contract deliveries during the past week have been on a better scale than in the previous week, and price conditions keep very firm. No new contracts of any consequence are looked for during the remainder of the current month, but quite a number of existing ones are due to expire before the end of September, and sellers are anticipating an improvement within the next few weeks. Midland varieties—Staffordshire and Derbyshire—are steady at 75s. 6d. and 74s. 6d. per ton respectively for delivery in the Manchester price zone. Other makes are very quiet, but at about 86s. per ton for Middlesbrough, up to 92s. 6d. for Scotch, and 87s. 6d. for West Coast hematite—all delivered in the Manchester district—prices are maintained. Bar iron is quiet, but steady, at £10 15s. for Lancashire Crown quality, and £9 15s. for No. 2. On the whole, there is only a very moderate demand for constructional steel against contracts, but locomotive builders are mostly busy, and are specifying for fair quantities of material. Bright-drawing bars are in good request still, but re-rolled sorts are slow and weak. Joists are quoted at £8 2s. 6d. per ton, tank plates at £8 17s. 6d., boiler plates at £9 17s. 6d., large bars at £9 2s. 6d., and small re-rolled bars at from £8 2s. 6d. to £8 5s., according to quantity. Little further change in values has occurred in the foreign steel section, but for the most part users are indifferent at the moment, and inquiry is slow.

BARROW-IN-FURNESS.

Hematite.

There is a further improvement in the hematite pig iron trade in this district, and makers find their entire output spoken for. The tendency to place orders for forward delivery has further developed, and it is certain that any further improvement in business will necessitate the increasing of output. If the steel trade was on a better foundation, the increase of the number of furnaces in blast would have already taken place. There is a fair trade with America and the Continent, and these markets show a tendency to improve. The business in special qualities is very good, but in manganese alloys there is a slight falling off. Local iron requirements for steel departments have been thin of late, but will improve for a short time unless further steel orders come to hand to maintain the demand. Iron ore is steady with better prospects. Local ore is finding slightly better trade outside the district, and foreign ore is in steady demand. The steel trade is not so good, although the Workington mills will have more work than they have had in recent times. At Barrow the rail mills have restarted, but the number of orders held is not heavy. The hoop and small section mills are better circumstanced.

Shipbuilding.

There will be launched from Vickers-Armstrong's yard here to-day—Thursday—a torpedo destroyer and a submarine of the latest class. These launches will take place on the same day, and both craft are for the British Admiralty.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Conditions.

THERE is nothing very new to say about the state of the various branches of the steel trade carried on in this district. While some of them are doing well, others are not at all satisfactorily employed, and the number of bad patches to be found in local industry is large. The output of basic steel continues high, but new inquiries and orders for heavy steel generally leave much to be desired. It is still to the special departments that one has to look for bright spots. Modern developments in engineering have created many new demands for steel, and the firms which have equipped themselves to deal with these needs are very favourably situated. Among these good lines are stampings and alloy steel for the automobile industry, and stainless and non-corrodible steels to meet a variety of purposes. The wire and wire rope trades are also enjoying better employment than they have had for some time.

Railway Requirements.

The home railway companies are giving out a certain amount of new construction to private firms, but the overseas demand for railway material remains at a low level, except in the case of rails. The local plants turning out tires, axles, and springs could do with a great deal more work. One thing which would help the steel trade to a notable extent would be a revival of the building of wagons for private owners. There has been little or nothing done in that department for two or three years. As there is still a surplus of wagons in the country, the prospects cannot be considered very promising. A number of railway orders for coaches and wagons have been placed during the past week, and firms with local associations have booked a good share of these.

The Lighter Trades.

Owing to the weather conditions, which have not encouraged gardening work, and the light hay crops, the season for farm and garden tools, and parts of implements, is only moderate. There is, however, good employment in the machine knife section, which is not troubled much by foreign competition. Many complaints of slackness are heard in the cutlery trade, but at the same time there is a large output of stainless table knives, and the trade appears to be on a more stable basis than it was a few years ago. There is an increasing number of firms which are able to carry on profitably through adapting their organisation to changed conditions, and enterprise in gaining business. Improvements have been brought about in the style and quality of the cheapest grades of knives which are now in demand. There is always a steady trade in goods of the first quality, and firms producing these are able to report favourably on their position. The demand for electro-plate is on a considerable scale, while in sterling silverware a fair amount of business is being done with London houses. Tenders for 6500 solid steel table knives, and a like number of spoons and forks, are being invited by the Air Force.

A New Coal-cutting Machine.

The Hardy Patent Pick Company, Ltd., of Sheffield, has recently brought out an electrical heading machine for colliery use, which is being used in increasing numbers in the mines of Great Britain, and particularly in the Durham and Northumberland coalfield. Speeds as high as 50 up to 120 square feet per hour have been attained. The brake horse-power to drive the machine is only 2½. The weight of the coal-cutting machine itself is about 400 lb., and the total equipment weighs, when packed, about 8 cwt.

A Panel of Arbitrators.

The Sheffield Chamber of Commerce has established a Court of Arbitration, with a panel of arbitrators, representing practically every class of trade in the district. Mr. A. J. C. Walters, secretary of the Chamber, has been appointed registrar. Members of the Chamber having disputes of a commercial nature are advised to apply to the Chamber for advice regarding their settlement, and the Council express confidence that firms which do this will find that they can save time and money.

Sheffield Works Scheme.

In reply to the appeal of the Government, that local authorities should hasten the preparation of plans in connection with schemes for dealing with unemployment, Sheffield Corporation has decided to submit a list of works involving an aggregate expenditure of £867,535, which it is prepared to put in hand, subject to the granting of adequate financial assistance. The largest scheme is one for the construction of a reservoir on the moors at Burbage, on the Derbyshire side of the city, the estimated cost of which is £650,000. The works also include paving, road widenings and sewerage schemes. The road widenings are :—Bawtry-road, £11,000 ; Greenland-road to Catley-road, £13,000 ; Bocking-lane to Greenhill-road, £30,000 ; River Don-street, £13,000 ; Holywell-road to Barrow-road, £13,500 ; Archer-road to Hutcliffe-road, £18,000 ; Shirland-lane bridge, £23,185. The proposed sewerage schemes will cost a total of £31,100, the largest items being : —Broomgrove-road, &c., £7500 ; Greenland-road, £8700 ; Prince of Wales-road, &c., £10,000. Several sewerage improvements have recently been carried out in the Handsworth Woodhouse district of Sheffield, which was incorporated in the city in 1921, and the latest of them was completed last week. It consists of a new sewer, 2 miles long, running from Woodhouse Mill to Handsworth, which has been constructed since last May at a cost of £15,000. It has provided work for 110 men, 70 of whom were local unemployed owing to the depression in the coal trade.

Progress of Hull Schemes.

Two of the great schemes projected at Hull, to which reference was made last week, have since moved forward. The City Council has appointed Mr. Frederick Palmer and Sir Henry Maybury as expert advisers on the scheme for the abolition of the railway level crossings. The question of providing a water supply for the proposed large paper-making factory has also been dealt with by the Council, which has agreed to supply 16,000,000 gallons per week, rising later to 20,000,000, from the Holderness Drain, the Leven Canal, and the Foredyke Stream.

The Great North Road.

Last week I reported that the Nottinghamshire County Council had adopted a scheme for the widening of the Great North-road in the county to 30ft., at a cost of £250,000, towards which the Ministry of Transport will contribute £187,500. The Kesteven County Council of Lincolnshire has also decided to carry out work on the Great North Road, the reconstruction of which is to be completed, together with the making of the Stamford by-pass road, at a cost of £100,000, subject to the Road Fund making a satisfactory grant, and to the Stamford Corporation contributing one-third of the net cost of the by-pass road. Another road scheme which the Kesteven Council proposes consists of improvements at Honington, to cost £8000.

Rotherham and Doncaster Schemes.

Rotherham Borough Council has agreed, subject to the co-operation of the West Riding County Council and the promise of a State grant of at least 60 per cent., to make arrangements for carrying out the construction of Herringthorpe Valley road, at an estimated cost of £100,000, in order to provide employment during the winter. At Doncaster, the substitution of trackless trolley vehicles for tramcars is proceeding. It has been decided to apply to the Ministry of Transport for sanction to borrow £14,025, required for immediate work in connection with the conversion of five routes, and also to invite tenders for the supply of twelve additional trackless vehicles and six petrol omnibuses. The Doncaster Council has also accepted tenders, amounting in all to £64,000, for the erection of three elementary schools, at Intake, Tickhill-road, and Wheatley.

NORTH OF ENGLAND.

(From our own Correspondent.)

New Cunarder Order Expected.

CONSIDERABLE interest has been aroused in shipbuilding circles on the North-East Coast by the performances of the "Bremen" and the "Mauretania," and the probability that the Cunard Company will make a bid to recover the Atlantic speed record by placing an order for a new liner. A proposed new Cunarder has been under consideration for about two years, and numerous rumours have been circulated about the suggested vessel. All along Swan, Hunter, and Wigham Richardson, Ltd., have been favourites for the work if the Cunard directors agreed to proceed with it, and it could scarcely have been otherwise in view of the great reputation the famous Wallsend firm has built up and the remarkable and long-continued achievements of the "Mauretania." Plans for the building of a super-Cunarder have been under careful discussion for a long period, but necessarily they have not been disclosed. It is almost two years since plans were made in regard to the Wallsend shipyard whereby it was definitely established that a vessel of 1000ft. length could be built in the yard. It does not follow, of course, that the Cunard line will decide to construct a vessel of that size. The company may prefer a smaller ship, with the object of greater speed. There are other yards in which a 1000ft. ship could be built, including the Vickers-Armstrong yard at Walker-on-Tyne, where the berth would require little alteration, whereas at the Wallsend yard some re-arrangements would be necessary. Meanwhile the directors of Swan, Hunter and Wigham Richardson, Ltd., are calmly awaiting the final decision of the Cunard Company.

Shipbuilding Outlook.

During the past few weeks there has been a marked falling off in orders for new vessels, and some anxiety is shown regarding the future in view of the present rapid rate of production. Orders are certainly not coming forward in sufficient quantities to maintain the industry at the required standard. A number of inquiries are in the market, however, and there is a prospect of a few orders being given out for cargo vessels and oil-tankers. The latter class of vessel, which largely assisted in keeping the industry going on the North-East Coast in the lean years subsequent to the war, has not been in much demand for some time, but a revival is now looked for. It is also possible that more Canadian Lakes steamers will be wanted in the autumn, and the prospect of additional foreign orders is fairly favourable. This week Sir W. G. Armstrong, Whitworth and Co., Ltd., have booked contracts for two motor tankers of about 9000 tons each for Norwegian owners.

Cleveland Iron Trade.

Business in the Cleveland iron trade is more or less held up through holiday influences, the general disposition being to postpone further transactions until the beginning of September. Buyers are admittedly apathetic, but sellers also are in no mood to press for business, as they are fairly well sold for some time to come. Several idle furnaces are prepared for rekindling, but adequate supplies of ironstone, foreign ore and coke must first be assured. In the near future the output of Cleveland pig iron is likely to reach normal, although the number of blast-furnaces in operation is not likely to exceed fifty, as compared with sixty and seventy in normal pre-war times. The output per furnace has been much increased since 1914. Marketable iron for early delivery has almost vanished, and the few trifling parcels merchants become possessed of from time to time command exceptionally high figures. Iron, however, is offered freely for forward delivery. The export trade is slow, exporters being unwilling to pay the prices named. No. 1 Cleveland foundry iron is 75s. ; No. 3 G.M.B., 72s. 6d. ; No. 4 foundry, 71s. 6d. ; and No. 4 forge, 71s.

Hematite Pig Iron.

Values of East Coast hematite pig iron are stiffening, but the upward movement is much too slow to meet the views of manufacturers, who complain that they still

have to accept orders at comparatively low and altogether unremunerative figures. Makers have little or no prompt iron for sale, and second-hands are not pressing for business, as they hope shortly to make better terms than are at present obtainable. Both home and continental consumers are buying moderate lots. Quotations vary, but the basis of values may be put around 75s. 6d. for ordinary qualities, with No. 1 quality at a premium of 6d. per ton.

Ironmaking Materials.

Supplies of foreign ore are coming forward better. Little or no effort, however, is made to transact new business. Merchants are not in a position to negotiate at all extensively, except for delivery well ahead, and consumers are heavily bought up to the end of next year. Nominally market rates are based on best Rubio at 24s. 9d. per ton c.i.f. Tees. The scarcity of Durham blast-furnace coke threatens to become more acute. The minimum quotation for good average qualities is 21s. 6d. delivered at North-East Coast works.

Manufactured Iron and Steel.

The manufactured iron and steel trade presents no new features of moment. Works are actively employed. New business is quiet, and resumption of market activity is not looked for until early next month, when buying for autumn needs is expected to be on a heavy scale. Prices are firmly maintained.

The Coal Trade.

The coal marketing schemes for Northumberland and Durham are now being drafted to be submitted to the Mines Department, which has intimated that they must be ready by October 15th, and put into operation by January 1st. So long as trade continues as good as it is at present there will be no need to reduce output on the quota system or to fall back on minimum prices. The real difficulties will begin when trade is slack and there is intensified competition among home and foreign coal producers for limited business offering. At the moment there is plenty of business circulating, both for prompt and over the remainder of the year, and the trend of the market is encouraging to owners. Fitters find great difficulty in meeting the spot demands, and all descriptions are scarce. Tonnage supplies have become plentiful, and enabled contractors to stem freely, not only for full current commitments, but also against accumulations of orders delayed through the tonnage scarcity of the past few weeks. Continental competition at all centres is becoming keener, but merchants consider they will be able to hold their own so long as there is no abnormal rise in forward coal prices or freight rates. Fitters for Northumberland steam coals, in nearly every case, report full order books for the next two or three weeks. Best qualities are 15s. 6d. to 16s., and stiffly indicated at this range. Tyne primes are firm at 14s. 6d. to 14s. 9d. Small steams are in restricted supply under heavy bookings, and 10s. to 10s. 6d. is now quoted for best or special makes, while secondary qualities command 9s. 6d. Very little change is shown in the Durham market apart from coking coal, and the steady tone of last week is fully maintained. The gas coal trade is active. Best sorts are fully 16s. 9d., and secondary 15s. 6d. to 16s. There are steady shipments of bunkering coal to the coaling stations, and producers of best and superior descriptions are in a very fair way to maintain a basis of 16s. 9d. to 17s. 3d. Ordinary bunkers are 15s. 6d. to 16s. Good trade is offered to manufacturers of foundry coke, especially ordinary kinds, which are 23s. to 24s. Home needs are substantial and the foreign market is satisfactory, although the tonnage available for export is a little short. Special foundry coke keeps to 24s. to 26s., and beehive coke to 28s. 6d. to 32s. 6d., while gas makes at 21s. 6d. to 22s. show steadiness.

SCOTLAND.

(From our own Correspondent.)

Continued Quietness.

Conditions in the steel, iron and coal markets show little change on the week. Buyers are acting with considerable caution, and business is more or less confined to immediate requirements. The possibility of still keener continental competition causes some anxiety in some quarters, but others regard the movement of prices abroad as a temporary one, as production costs abroad are evidently on recent lines. Foreign inquiries on the whole are still restricted, and while some are inclined to look for early improvement, there appears little likelihood of an expansion in the near future.

Steel.

The majority of the steel works are now running on lines similar to those which obtained during the two or three months prior to the annual holidays. Inquiries to hand are somewhat below expectations, owing possibly to the slump in continental prices, but it is said that makers are not at all apprehensive of their prospects. Local demands for steel are fairly steady, and are likely to remain so as long as the volume of work on the Clyde is maintained at present levels. Business in home steel plates and sections is steady, though not large. Steel tubes are still comparatively well placed, despite a falling off in export demands for butt-welded sorts. The past six months has been a very busy period in the tube trade, and producers are confident that the present lull is only a temporary one. Just at present tube makers experience a drop in the price of their raw materials, owing to the drop of 5s. per ton in continental tube strip. Steel sheet-makers have a fair amount of business on hand for light gauges, but the heavy descriptions are still somewhat neglected. Galvanised sheets are fairly busy, though foreign demands could be improved.

Iron.

Though there has been some slight improvement of late, the position of the bar iron industry is most disappointing. The present rate of production is difficult to maintain, and though prices in other parts of the country have been raised, the quotations for Scottish products remain unaltered. The re-rolled steel department may perhaps benefit to some extent by the reduction in continental semis, but the mills are not running with regularity at present.

Pig Iron.

It is reported that the number of furnaces engaged on the production of basic iron has been increased, but there has been a corresponding decrease in the number of furnaces employed on other makes. The change has been brought about by the high cost of steel scrap, necessitating steelmakers to utilise a larger proportion of pig iron. There are twenty-six furnaces in blast in Scotland, twelve of which are producing hematite, nine ordinary, and five basic.

Scrap.

Prices of scrap remain firm at £3 16s. 3d. per ton for heavy steel and 70s. per ton for cast iron machinery scrap.

Coal.

The position in the Scottish coal trade continues fair. The majority of the collieries are fully employed, and outputs are readily disposed of. Exports have been accelerated by a better supply of steamers, and the collieries mainly interested have now very little surplus fuel on offer for immediate disposal. The market is firm for most descriptions, though on occasion treble nuts may perhaps be secured a trifle under the quoted rate. Lanarkshire splints and Fifeshire steams are strong. Third-class Fifeshire steams are tending easier, but the price has not weakened so far. Aggregate shipments for the past week amounted to 274,208 tons, against 238,049 tons in the preceding week and 221,519 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

It can scarcely be said that the steam coal trade has recovered from the effects of the holidays, for the reason that even now there has not been a full return to work of the miners, and as a consequence supplies of coal, except most descriptions of large, are very scarce. The tonnage position at the end of last week was by no means satisfactory, inasmuch as there were twenty-five idle tipping appliances and only nine steamers waiting to berth. Over the week-end, however, tonnage came to hand more freely, with the result that the situation was reversed, as on Monday there were twenty-one vessels waiting to get into berth and only nine tips were idle. Steamers in many instances are not getting the despatch hoped for, owing to the shortage of coals, especially smalls and sized qualities. If collieries could get the quick clearance of some of the large coals which they have standing, there might be a chance of improving the supply of other descriptions, as no doubt collieries would in some cases be able to work more regularly. Shipments last week were naturally adversely affected by the holidays in the coalfield, and at the docks. It is no surprise to find that the total was only a shade over 300,000 tons, as compared with over 578,000 tons in the preceding week, which means that there was a reduction of over a quarter of a million tons. There should be some improvement this week, though business generally has a quiet appearance. At the same time it is strange to find that exporters have had great difficulty in taking up tonnage for loading this week and next, owing to the tightness of loading stems, and this has had a weakening effect upon outward freight rates for tonnage in a prompt position. It is quite possible that the conditions generally will be somewhat featureless throughout the remainder of this month, but it is fully expected that next month will see an expansion in operations.

Foreign Coal Exports.

The figures of foreign coal exports for the month of July as displayed by the Customs returns are very interesting, inasmuch as the total of 2,320,967 tons is an advance of 659,113 tons upon the quantity for the corresponding period of last year for South Wales. Furthermore, the total compares with just over 2,100,000 tons for the preceding month of June, and it forms the largest quantity exported to foreign destinations as cargo since November, 1923. These figures afford satisfaction, as they provide evidence of an expansion in the coal trade, and, as a matter of fact, they may come as a surprise to many, in view of the comparatively quiet conditions which have prevailed of late, but the secret probably is that business is now more centralised than ever, and shipments direct to buyers abroad are on a far larger scale.

Increased Minimum Prices and Output Regulation.

It has, of course, been known that the Executive Committee of the South Wales Coal Marketing Association was busy on the new scheme for the regulation of prices and output, but the market was scarcely prepared for the announcement made at the end of last week, which shows that the scheme is complete, except for the adjustment of a few details. The Committee hopes to complete its work within a fortnight, and a communication will then be addressed to all the collieries setting forth the procedure to be followed. Meantime it is announced that the joint scheme is to come into operation as from October 15th, while another matter of some importance is the fact that minimum prices of coals in Groups 1, 2, and 3, viz., large coals, are to be raised by 3d. per ton as from October 1st. The Committee has therefore given the trade fair notice of this advance, so as to have as little disturbing effect as possible upon operations. As conditions are at present, it might be considered that the market does not warrant any advance in large coals, for which the outlet is restricted, but there is no doubt that an expansion in the foreign demand will be experienced later. The advance in the prices means that the minimum prices will, as from October 1st, be 20s. for best Admiralty large, 18s. 6d. for best dry large, and 18s. 3d. for best Monmouthshire large. Small and sized coals are not dealt with, as the prices of these qualities are already 1s. 6d. to 2s. above the minima. The new scheme differs in some details from previous proposals for the regulation of production, and all undertakings other than single collieries are to be prohibited from producing a net output in excess of its quarterly allocation, except for the purpose of carrying forward deficiencies from one quarter to another in the same year or of complying with commitments under forward contracts. The question of the single collieries has caused some difficulty, for the reason that to cut down their production, even in a small measure, might so increase their production costs as to make it impossible for them to operate. It is easier for a concern with a group of collieries to regulate its output to comply with a scheme such as is now proposed. The result is that special provision is made for single colliery concerns, and, subject to certain conditions, they may raise in any quarter an amount additional to their quarterly allocation up to, but not exceeding, one-fourth part of the difference between their conventional output and their quarterly allocation. The membership contribution is to be ¼d. per ton and the penalty for producing outputs in excess of the quarterly allocations is 2s. 6d. per ton, calculated on the excess production, while the compensation for underproduction is a maximum of 2s. per ton.

Current Business.

The tone of the market generally is very quiet, and comparatively little business is passing. Supplies of most descriptions of large coals are easily available for prompt loading, but all other qualities are exceedingly firm and scarce, and are likely to remain so for the remainder of this month. Patent fuel makers are well stemmed, and there is a steady demand for this commodity, while coke is readily absorbed. The inquiry for pitwood was a little on the slow side, but supplies were not over-plentiful, and prices were about 32s. 6d. to 33s.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Hopkinsons, Ltd., of Huddersfield, ask us to announce that Mr. Richard Leslie Brown has been appointed deputy managing director of the company.

Mr. A. E. Halliwell, late engineer in the marine department of Foster, Wheeler, Ltd., has taken up the duties of director and engineer with Phillips and Sons (Chiswick), Ltd., of 42, Waterford-road, Walham Green, S.W. 6.

CONTRACTS.

The General Electric Company, Ltd., has received from the Metropolitan Water Board an order for twelve months' supply of Osram lamps.

The Lafarge Aluminous Cement Company, Ltd., has received from the Halifax (Nova Scotia) Harbour Commission an order, amounting in value to upwards of £150,000, for cement for use in the construction of a large pier.

The B.E.N. Patents, Ltd., of 92, Tottenham Court-road, London, W. 1, has received an order from the Metropolitan Asylums Board for the installation at the Western Ambulance Station, Fulham, of a high-pressure car washing plant, air compressor equipment and ambulance disinfecting unit.

The Stirling Boiler Company, Ltd., of 32, Farringdon-street, London, E.C. 4, has received from the West Midlands Joint Electricity Authority the order for the complete steam-raising equipment at the new power station at Ironbridge. The order comprises three Stirling high-duty water-tube boilers of the Tridrum type, pulverised fuel equipment, and all accessories.

Yarrow and Co., Ltd., of Scotstoun, Glasgow, have received the following orders :—(*a*) From the Royal Yugo-Slav Government for the construction of a powerful flotilla leader. The vessel is to be propelled by turbines and to be equipped with Yarrow water-tube boilers and the latest improvements in every respect ; (*b*) from the Colombian Government to build three shallow draught gunboats ; and (*c*) to instal the latest type of Yarrow water-tube boilers in the fast passenger and cargo vessels now being built by Cammell Laird and Co., Ltd., Birkenhead, for the Canadian National Railways Company.

The English Electric Company, Ltd., has received from the Croydon Corporation an order for the complete equipment of a new switch house at the latter's new power station. The installation, which is to the designs and specification of Mr. A. C. Cramb, the borough electrical engineer, will include electrically-operated compound-filled switchgear of high-rupturing capacity with a special arrangement of duplicate bus-bars. It will form the main control for the turbo-alternator plant, including a new 25,000 kW set, and for group feeders to the existing feeder switchgear. The order, which is valued at £44,300, includes reactors, synchronising gear and control boards, telegraphs, telephones and multi-core cable, earthing equipment, &c.

The Lamme Medal.—The first Benjamin G. Lamme Medal has been awarded and presented to Mr. Allen Betram Field, an English inventor. The Lamme Medal was created by provisions in the will of the late Benjamin G. Lamme, electrical scientist of note and chief engineer of the Westinghouse Electric and Manufacturing Company. It is given for meritorious achievement in the design of electrical machinery. The recipient is chosen by the Lamme Medal Committee of the American Institute of Electrical Engineers, before which group the presentation has to take place. The specific accomplishment for which Mr. Field was awarded the medal was "the mathematical and experimental investigation of eddy current losses in large slot-wound conductors in electrical machinery." Mr. Field, now a consulting engineer for the Metropolitan Vickers Electrical Company, Ltd., of Manchester, received his early education in England, but much of his work was done in the United States. He attended the Finsbury Technical College, St. John's College, Cambridge, and the University of London.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	19/6 to 22/–
(1) Spanish	24/–
(1) N. African	24/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	24/9

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 0 0	—
No. 1 Foundry	3 18 6	—
No. 3 Foundry	3 16 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 15 6	3 15 6
No. 1	3 16 0	3 16 0
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
Midlands—		
(3) Staffs.—	(*Delivered to Station*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 11 0	—
„ „ Foundry	3 13 6	—
3) Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 8 6	—
(1) Derbyshire—		
No. 3 Foundry	3 16 0	—
Forge	3 12 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 12 6	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 5 6 (a) / 4 7 6 (b) / 4 11 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 0 0 to 11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 12 6	7 12 6
Sections	8 2 6	7 2 6
Steel Sheets, ¼in.	9 0 0	8 7 6
Sheets (Gal. Cor. 24 B.G.)	13 17 6	13 12 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 12 6	—
Angles	8 2 6	—
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 2 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 2 6	—
„ (Small Round)	8 2 6 to 8 5 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 17 6	—
Sheffield—		
Siemens Acid Billets	9 10 0	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	7 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	8 10 0	—
Midlands—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 10 0 to 6 15 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 12 6	—
Angles	8 2 6	—
Joists	8 2 6	—
Tees	9 2 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	208 10 0
„ „ (three months)	212 10 0
Copper (cash)	73 18 9
„ (three months)	74 17 6
Spanish Lead (cash)	23 5 0
„ „ (three months)	25 5 0
Spelter (cash)	24 17 6
„ (three months)	25 0 0
Manchester—	
Copper, Best Selected Ingots	79 5 0
„ Electrolytic	85 0 0
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3
Brass Tubes (Basis Price), lb.	0 1 1
„ Condenser, lb.	0 1 3
Lead, English	24 12 6
„ Foreign	23 5 0
Spelter	25 2 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	3/6½ per lb.
Ferro Tungsten	3/3½ per lb.
	Per Ton. Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0 7/6
„ „ 6 p.c. to 8 p.c.	£23 0 0 7/–
„ „ 8 p.c. to 10 p.c.	£23 0 0 6/6
„ „ Specially refined	
„ „ Max. 2 p.c. carbon	£34 0 0 12/–
„ „ „ 1 p.c. carbon	£38 0 0 15/–
„ „ „ 0·70 p.c. carbon	£42 0 0 17/–
„ „ „ carbon free	1/2 per lb.
Metallic Chromium	2/6 per lb.
FerroManganese (per ton)	£13 15 0 for home
	£13 10 0 for export
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/– per unit
„ „ 75 p.c.	£19 10 0 scale 6/– per unit
„ Vanadium	13/– per lb.
„ Molybdenum	4/– per lb.
„ Titanium (carbon free)	1/– per lb.
Nickel (per ton)	£170 to £175
Ferro-Cobalt	9/4 per lb.

FUELS.

SCOTLAND.
(*Prices not stable.*)

	Export.
Lanarkshire	
(f.o.b. Glasgow)—Steam	14/–
„ „ Ell	14/6
„ „ Splint	15/9 to 17/–
„ „ Trebles	15/6 to 16/–
„ „ Doubles	14/6 to 15/–
„ „ Singles	12/9
Ayrshire—	
(f.o.b. Ports)—Steam	13/6
„ „ Jewel	16/6
„ „ Trebles	15/–
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	12/– to 15/–
Screened Navigation	17/6 to 18/6
Trebles	16/– to 17/–
Doubles	14/6 to 15/–
Singles	13/–
Lothians—	
(f.o.b. Leith)—Best Steam	14/–
Secondary Steam	13/6
Trebles	15/6
Doubles	14/6
Singles	12/6

ENGLAND.

(8) N.W. Coast—	
Steams	24/– to 25/–
Household	38/– to 51/–
Coke	26/– to 26/6
Northumberland—	
Best Steams	14/6 to 15/–
Second Steams	13/9 to 14/–
Steam Smalls	9/6 to 10/6
Unscreened	13/– to 13/6
Household	21/– to 26/–
Durham—	
Best Gas	16/6 to 16/9
Second	16/– to 16/6
Household	21/– to 27/–
Foundry Coke	22/– to 28/–

Sheffield—	Inland.	
Best Hand-picked Branch	25/6 to 26/6	—
Derbyshire Best Bright House	19/– to 21/–	—
Best House Coal	19/6 to 20/6	—
Screened House Coal	17/6 to 18/6	—
„ „ Nuts	15/6 to 16/6	—
Yorkshire Hards	15/– to 16/–	—
Derbyshire Hards	15/– to 16/–	—
Rough Slacks	9/– to 10/–	—
Nutty Slacks	7/– to 8/–	—
Smalls	3/– to 5/–	—
Blast-furnace Coke (Inland)	14/6 at ovens	—
Furnace and Foundry Coke (Export), f.o.b.		21/6 to 22/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	19/9 to 20/–
Second Smokeless Large	19/6 to 19/9
Best Dry Large	18/9 to 19/–
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/– to 18/3
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/3 to 17/9
Best Steam Smalls	13/9 to 14/6
Ordinary Smalls	12/6 to 13/–
Washed Nuts	20/– to 23/6
No. 3 Rhondda Large	20/– to 21/–
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/6
„ „ Through	15/6 to 16/6
„ „ Smalls	13/6 to 14/–
Foundry Coke (Export)	26/6 to 36/6
Furnace Coke (Export)	21/– to 23/–
Patent Fuel	20/– to 21/6
Pitwood (ex ship)	32/6 to 33/–
Swansea—	
Anthracite Coals :	
Best Big Vein Large	33/– to 36/6
Seconds	27/6 to 30/–
Red Vein	23/– to 27/–
Machine-made Cobbles	40/– to 44/–
Nuts	40/– to 44/–
Beans	23/6 to 25/6
Peas	18/– to 19/–
Breaker Duff	9/– to 9/6
Rubbly Culm	10/9 to 11/3
Steam Coals :	
Large	18/– to 19/–
Seconds	17/– to 18/–
Smalls	11/3 to 13/–
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum) 12/6

Ordinary Ship, Bridge and Tank Plates and Sections 10/– if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

German Reparations.

ONE of the greatest of the schemes for which France is taking material from Germany on account of reparations is the sinking of shafts and the equipment of a new colliery at Saint-Avault-en-Moselle in Lorraine, at a cost of 49,526,000 marks. Orders have also recently been placed to the value of 30,000,000 marks for iron and steel works plant, 19,024,000 marks for textile machinery, 7,536,000 marks for machine tools, 59,582,000 marks for other machines, 45,254,000 marks for shipbuilding, 28,480,000 marks for iron and steel and other metals. The contracts entered into for public works, as a whole, total 88,205,000 marks. They include improvements to the port of Tamatave in Madagascar, the construction of the barrage across the Rhine at Kembs, the canalisation of the Moselle, the construction of a dock at Saint-Nazaire, as well as the carrying out of many other works relating to ports and inland waterways and road improvements. It is curious to observe that the reparations include the cession of a license for the manufacture of a German light high-speed heavy oil engine to a well-known motor car firm. Although some home industries are adversely affected by these reparations, there is no doubt that they are largely responsible for the industrial activity, for without reparations many public works could not be put in hand, and such works benefit equally French manufacturers. While some makers clamour for a suppression of reparations, it is fairly certain that, if that were done, the situation generally would not be so good as it is now, and the official conviction that the national economy depends upon a continuance of a supply of material and goods on account of reparations strengthens the Government in its resistance to any attempt to suppress them so long as they are not replaced by monetary payments.

Coal.

By far the greater proportion of reparations is in the form of coal and coke, and while the prices of fuel supplied in this way are maintained by the Kohlensyndikat they do not compete with the French coal, but the importations of coal apart from reparations are certainly a menace to the home produced fuel. There does not seem to be any likelihood of prices of German coal imported into this country increasing, but French coalowners will probably be obliged to advance prices, especially now that the Belgians have taken the lead. The syndicate of coalowners in Belgium, comprising all the collieries except those in the Liége district, is now in operation, and prices have been advanced 5 and 10 francs a ton. The upward tendency of French coal prices is only kept in check, for the moment, by the possibility of any advance facilitating a more extensive importation from the Ruhr.

Strikes.

One feature of the labour situation on the Continent is that there are never any strikes of such magnitude or of such frequent occurrence as in Great Britain, and while that may be due to the absence of any real cause for strikes during a period when work is fairly plentiful, it may also be affirmed that foreign workmen are generally aware that strikes involve permanent losses to all concerned. At the time of the miners' strike in 1926 it was clearly seen abroad that Great Britain would never regain the trade it lost when the deficit of coal through the suspension of British exports was made good by an increased output in France, Belgium, Poland and other countries. There is now no deficit of continental coal, and trade has therefore become highly competitive. In the same way, the lock-out in the Lancashire cotton spinning industry is diverting business to mills in France and elsewhere, and this activity is benefiting many branches of the engineering industry, the result being that some of the trade which is diverted to foreign mills will necessarily remain there, even when the lock-out is terminated. It is true that unless wages are adjusted to the conditions of trade, the business will be lost in any case. The manufacturing industries have developed so considerably abroad that there was never a time when strikes and lock-outs were so ruinous as a means of settling industrial disputes.

Metropolitan Railway.

The Paris Metropolitan Railway system is in a continuous state of development, and at the present moment important works are being carried out for an extension of the lines from the Porte d'Auteuil and the Porte de St. Cloud to Vincennes in view of the traffic during the International Colonial Exhibition to be held there in 1931. These two lines at present terminate at the Grands Boulevards, and an interesting tunnel is being constructed along the boulevards to the Place de la République. The work is being carried on under difficult conditions, as there can be no surface openings along the Grands Boulevards, and the spoil is conveyed away by a separate tunnel to the St. Martin Canal. Two single track tunnels are being constructed one above the other, forming one block of masonry, and from the Place de la République two lines will diverge to Vincennes. The electrified line from the Bastille station of the Chemins de Fer de l'Est will be incorporated in the Metropolitan system, and the traffic facilities will be greatly improved in time for the exhibition.

Indo-China Works.

The French are doing valuable work in Indo-China in the way of improving communications and carrying out irrigation and drainage works, and the latest important undertaking is the construction of the Song-Cau Canal in Tonkin, which will allow of the mineral and agricultural products of a large province being conveyed to Haiphong. Its total length is 33 miles, but only for about 10 miles is it employed exclusively for the navigation of boats of 300 tons. Beyond that distance the canal narrows, and up to the point where it joins the river Song-Thuong it will feed a considerable number of irrigation canals over an extensive territory. The canal will allow of the working of coal and iron ore mines which have been neglected through lack of transport facilities.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

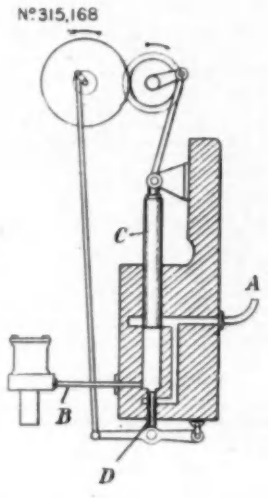
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

315,168. October 30th, 1928.—FUEL PUMPS FOR HEAVY OIL ENGINES, G. L. Kirk, of Harland and Wolff, Ltd., Finnieston Works, Glasgow; V. Mickelsen, A. Hammer and F. E. Rebbeck, of Harland and Wolff, Ltd., Queen's Island, Belfast.

This fuel pump is put forward as one which has no valves, but it has two plungers, both of which carry out the functions of valves. In the illustration the fuel oil inlet is shown at A and

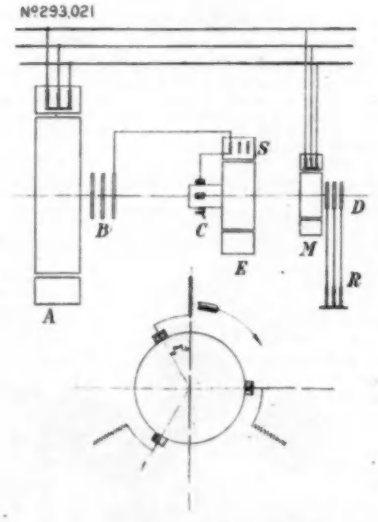


the outlet to the engine spray at B. The main driving plunger of the pump is marked C and the auxiliary plunger D. It will be seen that the two are interconnected by the driving gear in such a manner that the auxiliary plunger works at half the speed of reciprocation of the main plunger. The result is that on alternate strokes of the main plunger the delivery is by-passed back to the inlet. By a comparatively simple modification the pump may be arranged for feeding a two-stroke engine.—*July 11th*, 1929.

DYNAMOS AND MOTORS.

293,021. May 31st, 1928.—ASYNCHRONOUS ELECTRIC MOTORS, Forges and Ateliers de Constructions Electriques de Jeumont, of 75, Boulevard Haussmann, Paris.

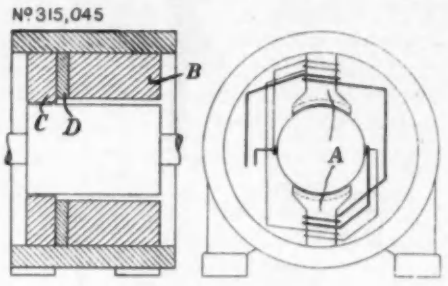
The object of this invention is to maintain phase compensation constant within wide limits of load variation without any appreciable increase in the slip of the induction motor at full load. A is the main asynchronous motor, the slip rings B of which are connected to the series exciter E. This exciter comprises a stator winding S in series with the commutator C. It is driven by an asynchronous motor M, the slip rings D of which are connected to a slip rheostat R. The lower illustration shows the angular direction of the negative lead or shifting of the exciter brushes in relation to the direction of rotation. The operation



of the motor arranged in accordance with the invention is as follows:—The exciter, comprising a stator winding and having negative brush lead possesses a resistant torque which is a function of the load on the main motor and increases with that load. The speed of the auxiliary driving motor, and therefore of the exciter, varies in an inverse manner to the load on the main motor and the compensation is maintained constant within wide limits of variation of the load, from about one-tenth of the load up to full load. It can be shown that the slip of the main motor compensated by a variable-speed series-wound exciter in accordance with the invention remains practically constant under varying load. This slip is substantially equal to what would be the slip of the main motor if provided with short-circuited rotor windings.—*July 11th*, 1929.

315,045. May 10th, 1928.—DYNAMO-ELECTRIC MACHINES, Frederick Agustus Eastwood, of 46a, Poplar-grove, Brooklands, near Manchester; and Metropolitan-Vickers Electrical Company, Ltd., of 4, Central-buildings, in the City of Westminster.

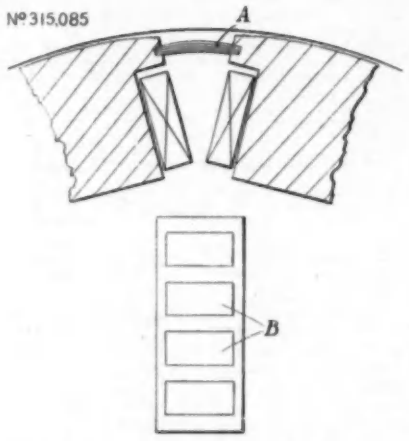
This specification describes a dynamo in which loss of flux in a portion of the magnetic circuit having high magnetic retentivity is minimised. Each of the poles A comprises a portion B formed



of magnetic material, such as sheet steel stampings, in the usual manner, and, in addition, a portion C formed of permanent magnet material of high retentivity, the portions B and C being separated from each other by non-magnetic material D. The object is to maintain a large residual flux in the magnetic circuit and consequently in positive and rapid building up of the voltage when the machine is started.—*July 11th*, 1929.

315,085. June 26th, 1928.—SYNCHRONOUS DYNAMO-ELECTRIC MACHINES AND SYNCHRONOUS MOTORS, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C. 2; and Giulio Schroeder, of Siemens Works, Stafford.

In accordance with this invention magnetic shunts A are provided in the magnetic path of synchronous machines so that the

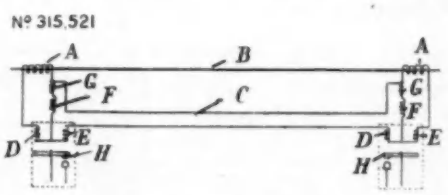


pole saturation and consequently the shape of the saturation curve can be influenced within desired limits. The shunts consist of packets of laminations made entirely or partly of magnetic material so that the influence of the shunts may be adjusted. In order that the shunts may not interfere with the ventilation of the machine openings may be cut in them as shown at B in the lower illustration.—*July 11th*, 1929.

TRANSMISSION OF POWER.

315,521. May 23rd, 1928.—ELECTRIC CABLE PROTECTION, Graham Leigh Porter and Ferranti, Ltd., both of Hollinwood, Lancaster.

The protective scheme described in this specification is arranged so that it will not operate under transient conditions. High-resistance pilot wires may also be used without unduly reducing the margin for discrimination between transient balanced conditions and unbalanced fault conditions. A current transformer A is provided at each end of the feeder B and the secondaries are connected together through pilot wires C. Two



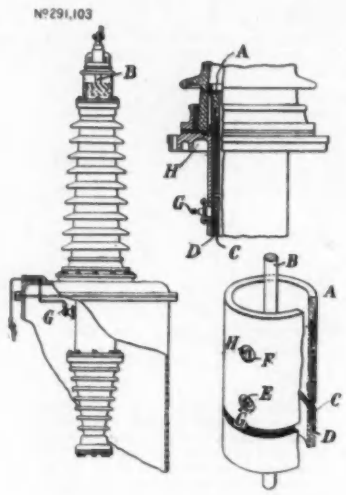
pairs of relay coils D and E are also provided, one pair being associated with one secondary winding and the other pair with the other secondary winding. In conjunction with each pair of relay coils a shunt circuit is used, which is composed of a resistance G and an inductance F and is connected between one end of the secondary winding and the junction between the two relay coils. Each pair of relay coils acts upon a balanced armature H carrying a movable contact associated with a corresponding fixed contact, and these contacts control a tripping circuit which is not shown. The theory of the scheme is fully described.—*July 18th*, 1929.

MEASURING AND TESTING INSTRUMENTS.

291,103. May 24th, 1928.—ELECTRIC CONDENSERS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

The object of this invention is to provide an electric condenser which may be used for obtaining a low voltage for the operation of measuring and similar instruments from a high-tension conductor. A cylinder A composed of insulating material surrounds a high-tension conductor B. Two cylindrical layers C and D are embedded in the cylinder A and a small opening is formed at F for making contact with the outer conductor. A similar opening E is also formed to expose the inner conductive cylinder to which the terminal G is connected. A second terminal H is connected to the outer conductive cylinder through an opening in the outer portion of the cylinder A. The two capacities between the high-tension conductor B and the inner conductive cylinder C and between the two con-

ductive cylinders C and D are in series, so that the voltage between the high-tension conductor B and the outer conductive

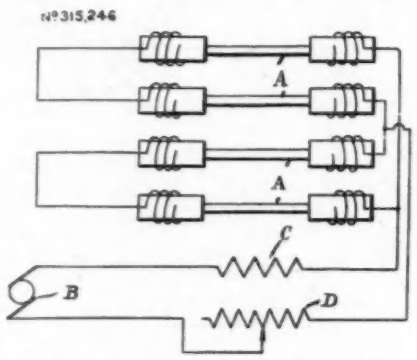


cylinder D will divide inversely as the values of the two capacities.—*July 11th*, 1929.

FURNACES.

315,246. April 10th, 1928.—ELECTRIC FURNACES, Automatic and Electric Furnaces, Ltd., and Lancelot William Wild, both of Elecfurn Works, North-road, Caledonian-road, London, N. 7.

A ballast resistance is used in accordance with this invention in order to tend to equalise the power input to an electric furnace as the bars age and increase in resistance, and to diminish the

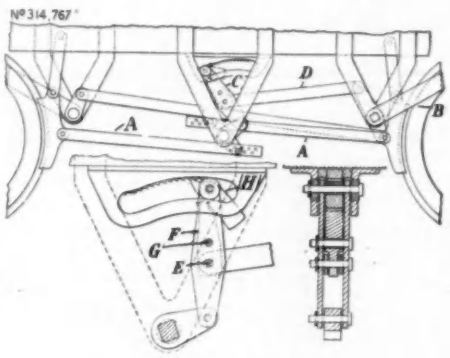


variation in output between the new and old conditions. As the furnace resistance increases with age the current falls and the E.M.F. at the furnace terminals rises, so that the diminution in power to the furnace is considerably less than it would be without any ballast resistance. In the drawing the resistor bars of the furnace are shown at A and are supplied with current from the generator B. The ballast resistance is shown at C and a controlling resistance at D.—*July 10th*, 1929.

TRAMWAYS AND RAILWAYS.

314,767. January 30th, 1928.—BRAKE GEAR, F. E. Dadd, 41a, Shakespeare-road, Bedford.

In this brake mechanism the brakes are automatically held in the "on" position, but can be immediately released by the simple operation of the brake lever. The brake gear A A is of normal pattern and is operated by the hand lever B. This lever is connected with the swinging double link C by the rod D, but

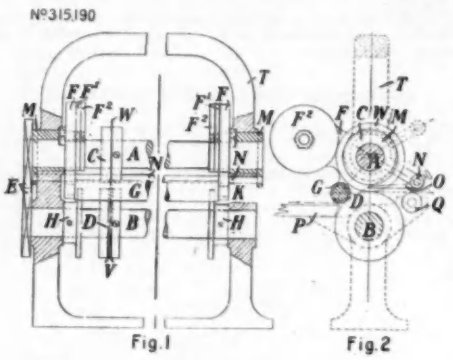


the pin E is slack in the slots in the link. Between the two parts of the link there is a lever F. The pin is a good fit in a hole in this lever, which pivots at G. The action of the weighted pawl H in holding the brakes on is obvious. When they are to be released the slack of the pin E in its slots results in the lever F swinging and its upper end knocks the pawl out of engagement with its rack.—*July 1st*, 1929.

MACHINE TOOLS AND SHOP APPLIANCES.

315,190. February 15th, 1929.—ROTARY PERFORATING MACHINES, J. H. Mellor, 48, Thompson-hill, High Green, Sheffield.

This invention relates to machines of the rotary type in which two spindles carry pairs of tool holders fitted with tools and arranged in such a manner that the tools are in contact one with another and that paper, card, and such like materials can be passed when the spindles are made to revolve. It relates particularly to the position, suspension and drive of the feed roller used thereon and the method of obtaining adjustment for thickness of material fed, pressure of feed and adjustment for depth of cut. In the drawing A and B are top and bottom spindles, carrying laterally adjustable tool holders C and D and geared together by toothed wheels E. Fig. 2 shows a cross section of the arrangement, the main frame T being dotted for clearness. The invention consists of two brackets F free to oscillate on the spindle A and carrying a composite roller G in close proximity to the tool W and yet arranged to be in contact with the distance discs H and the enlarged body of the tool holder D and the dies V on the bottom shaft, and yet allow adequate use of the open end in frame of the machine at K. The

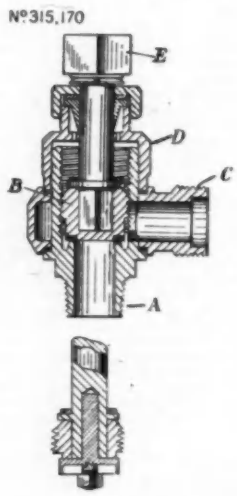


roller G is made to revolve frictionally as shown in the drawing or by interconnected toothed wheels from A or B. Feed pressure is increased by the addition of discs F1 F2 and the oscillating action accommodates any thickness of material passing. Provision is made for thickness of material in the excentric bushes M connected together by a rod N which carries strippers O for removing material from the tools. The swivelling of the bushes M simultaneously disengages the tools and removes the strippers to a position such as to give easy access to the tool holders. Paper and the like is fed along P in the direction of the arrow, under the roller G through the tools and dies, is stripped from the upper tool and carried forward, if necessary, by the back roller G to delivery. It has been found as the result of experiment with machines of this type that the closer the feed roller is to the operation in progress the better the control of the sheet.—*July 11th*, 1929.

MISCELLANEOUS.

315,170. November 7th, 1928.—WATERWORKS PILLAR TAPS, R. McAndrew, 4, Sir Thomas White's-road, Coventry.

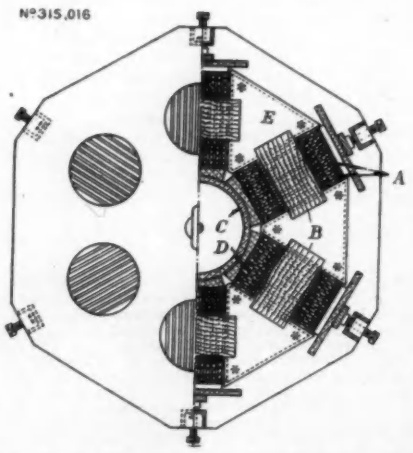
The object aimed at in this invention is to provide a tap which can be screwed into a water main under pressure, to form a branch service, and can also be used as a stop cock. It comprises



a ferrule A, which is screwed into the main by means of a familiar type of machine. It is provided with a screwed plug B which shuts off the flow of water. When the ferrule has been inserted and the machine removed, the branch body C is applied and is locked in place by the bonnet D, which carries the operating key E.—*July 11th*, 1929.

315,016. April 5th, 1928.—ELECTRICAL REACTANCE COILS, Jan Arthur Kuyser, of "Knowle Lodge," Sibson-road, Sale, Chester; Alfred George Ellis, of "Felthorpe," The Firs, Bowdon, Chester; and Metropolitan-Vickers Electrical Company, Ltd., of 4, Central-buildings, Westminster.

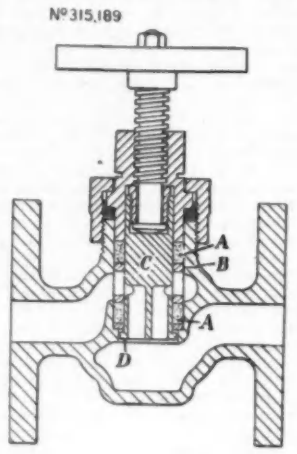
In an air core reactance constructed in accordance with this



invention the strong magnetic field is said to be negligible, and, if desired, the complete reactance may be enclosed in an oil-filled iron tank. The coils A are assembled in groups upon common cores B of insulating material, such as wood, and are arranged about a circular core C of insulating material, packing pieces D being inserted between the inner edges of the coils and the core C. In order to minimise leakage flux between the groups of coils, the angular spaces between the end coils of adjacent groups are filled with laminated electro-magnetic material.—*July 5th*, 1929.

315,189. January 26th, 1929.—PISTON VALVES, Sir J. Dewrance, 165, Great Dover-street, Southwark.

This valve is of the piston type, which, of necessity, must be packed to remain tight. The packing is shown at A A and is held by the cage B. In the event of the piston C of the valve



proper being taken out of the casing, the flange D on the bottom of an extension of the valve engages with the packing member and the latter is consequently simultaneously withdrawn. The remainder of the constructional details of the valve need no comment.—*July 11th*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

SATURDAY, AUGUST 17TH.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, Newcastle-upon-Tyne. Annual general meeting. 2.30 p.m.

SATURDAY TO SATURDAY, SEPTEMBER 7TH TO 14TH.

MODEL ENGINEER EXHIBITION, Royal Horticultural Hall, Vincent-square, Westminster, London, S.W. 1.

MONDAY TO SUNDAY, SEPTEMBER 9TH TO 15TH.

INSTITUTE OF METALS.—Annual autumn meeting, Düsseldorf, Germany. Monday, September 9th, in the Aula of the Lessing Oberrealschule, Ellerstrasse, Düsseldorf, 5 p.m. Eighth autumn lecture, by Dr. A. G. C. Gwyer, B.Sc., "Aluminium and its Alloys." Tuesday, September 10th, 9.30 a.m., in the Hall of the Eisenhüttenhaus, Verein Deutscher Eisenhüttenleute, 27, Breitstr., Düsseldorf. Reading and discussion of paper (see page 66, July 19th, 1929). Wednesday, September 11th, 9.30 a.m., in the Hall of the Eisenhüttenhaus, Verein Deutscher Eisenhüttenleute, 27, Breitstr., Düsseldorf. Reading and discussion of paper (see page 66, July 19th, 1929). Thursday, September 12th, 8.15 a.m., whole-day excursion to Messrs. Krupp, Essen. Friday, September 13th, to Sunday, September 15th, visits to Berlin and Holland.

TUESDAY TO FRIDAY, SEPTEMBER 10TH TO 13TH.

IRON AND STEEL INSTITUTE.—Autumn meeting at Newcastle-on-Tyne.

THURSDAY TO SATURDAY, SEPTEMBER 12TH TO 28TH.

SHIPPING, ENGINEERING AND MACHINERY EXHIBITION, Olympia.

SATURDAY TO SATURDAY, SEPTEMBER 14TH TO 28TH.

INSTITUTION OF NAVAL ARCHITECTS.—Summer meeting in Italy. For programme see page 380, April 5th, 1929.

FRIDAY AND SATURDAY, SEPTEMBER 20TH AND 21ST.

INSTITUTION OF WATER ENGINEERS.—Informal autumn meeting. Visits to the works of the Wakefield and Barnsley Corporations.

ANNUAL CONFERENCE OF THE INSTITUT INTERNATIONAL DE BIBLIOGRAPHIE OF BRUSSELS.—The eighth Conference Bibliographique Internationale will be held, by permission of the Governors and Professor Callender, in the Imperial College of Science, South Kensington, on Monday and Tuesday, September 16th and 17th next. The first day will be occupied with council meetings. The General Assembly and Conference, to which visitors are invited, will commence at 10 a.m., on the second day, when Professor A. F. C. Pollard will give the presidential address. The agenda include further proposals for the re-organisation of the Institute, reports of the Commissions on Cataloguing Rules, and on Documentary Technique, and a discussion on the possible unification of the aims and objects of international bibliographical organisations. In view of the fundamental importance of information services to science and technology, it is hoped that all those in this country who have at heart the organisation of information will endeavour to be present to welcome the delegates from abroad and assist in the discussion. The subscription to the Conference is ten shillings. Further information may be obtained from the organising secretary, Mr. H. T. Pledge, The Science Library, S.W. 7.